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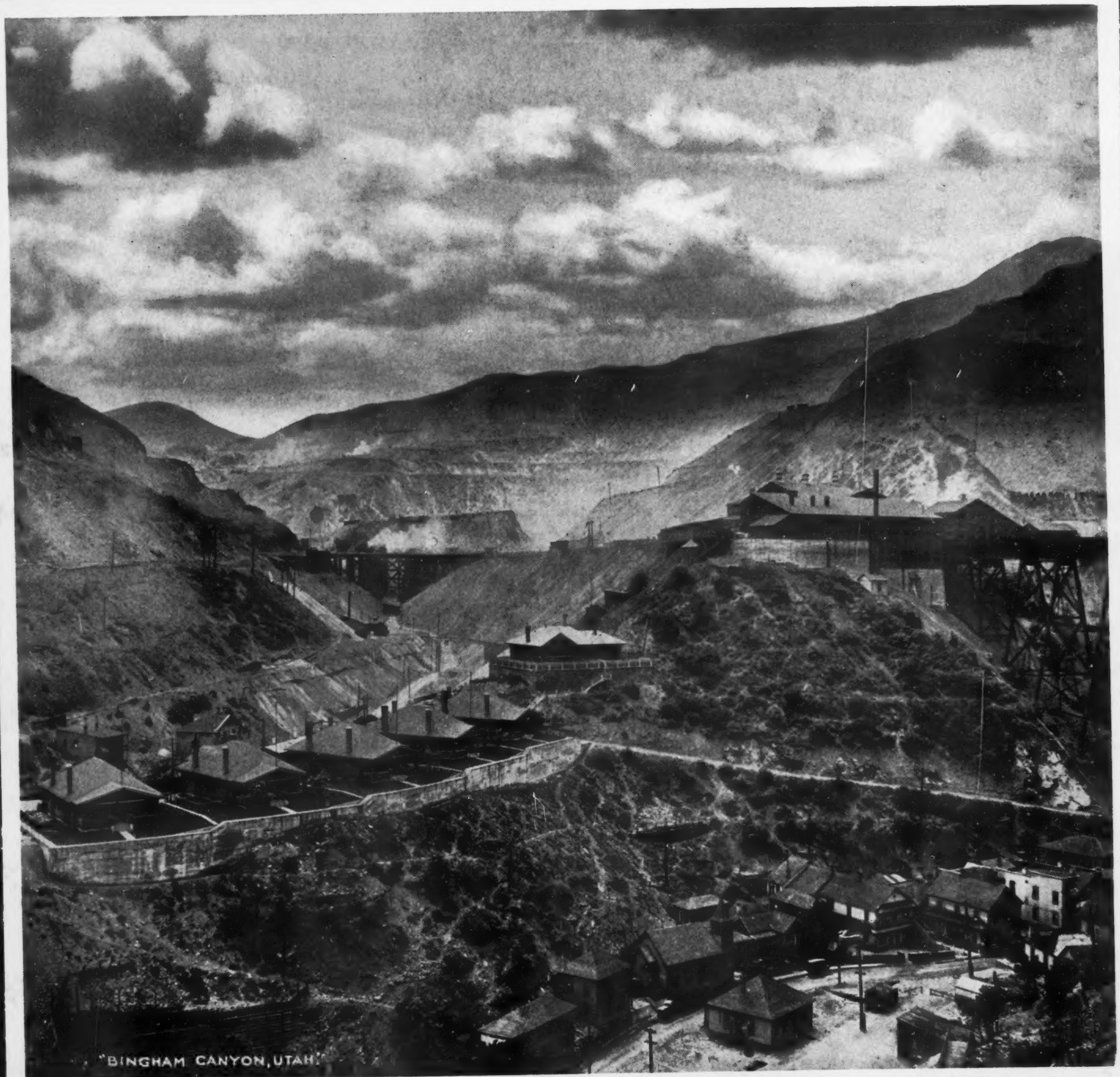


As It Seems To Us

HUNDRED YEARS OF WIRE ROPE

WIRE rope was first made and used just a century ago. No observation of the centenary is planned; but it is interesting to note, in passing, the great influence that this comparatively simple product has had in bringing modern construction and industry to their current levels. Without wire rope, high-speed elevators and mine hoists would be impossible; suspension bridges would never have reached their present development; aerial tramways such as are in operation at the Boulder Dam would not exist; and excavating machinery would still be comparatively crude.

Iron had been in service hundreds of years before anyone discovered that strands of it could be twisted into flexible cables of great strength. The first practical wire rope is said to have been introduced in Germany, in 1834, by Julius August Albert, a mine inspector of Hannover. Iron chains and hemp ropes were being employed for hoisting ore, but they were always breaking. Albert's innovation was an important contribution to mining practice, and it was not long until wire rope was in use throughout Europe.

Credit for introducing the new product in the United States fell to John A. Roebling, the eminent bridge builder and engineer. He had left Germany in 1831, but had kept in touch with engineering progress there by reading foreign scientific publications. While employed as a surveyor by the State of Pennsylvania, he was given an opportunity to study the workings of the portage railways by which canal boats were transported over a succession of ridges in the Allegheny Mountains. Engines mounted on the crest of every elevation drew each boat up an inclined plane and let it down a similar slope on the opposite side. This canal ran from Philadelphia to Pittsburgh, and constituted the principal means of moving heavy freight. Between Hollidaysburg and Johnstown, the boats crossed the summit of the Alleghenies at an altitude of 2,300 feet.

Huge hempen hawsers, some of them as much as 9 inches in circumference and a mile long, served as tows. They cost up to $3,000 each, and had to be replaced frequently. Roebling suggested that wire ropes be substituted, and offered to make one; but he met difficulty in convincing the canal companies that they would be effective. No one doubted their strength; but they questioned that iron wire could be made flexible enough to wind around the hoisting drums and predicted that no satisfactory covering could be devised to prevent water from getting in between the strands and setting up weakening corrosion.

Finally, in 1841, Roebling's persistence prevailed, and he turned out the first wire rope in this country at Saxonburg, the settlement which he had founded near Pittsburgh. This cable proved successful immediately, and wire rope was soon afterward adopted for all the portages on the principal existing canal systems. On the Morris Canal, alone, there were 22 such land crossings in a relatively short stretch between the Delaware River and the Jersey City basin.

Roebling's little factory prospered; and it was soon given a new impetus when its versatile director began designing and building suspension bridges. This type of bridge was known in the pre-Christian era, when twisted vines and leather straps served as cables; but its real utility dates from 1854 when Roebling proved for the first time at Niagara Falls that such a structure could be made strong enough to support the weight and to withstand the vibration of a moving railway train.

Realizing that he would have to have a better location for his factory if he were to retain his business, Roebling, in 1850, opened a new establishment at Trenton, N. J., which site was selected because of its proximity to New York and to Philadelphia. In its first year, this plant turned out 250 tons of wire rope valued at $40,000. Today, the annual production of wire rope in the United States is about 165,000 tons. The Roebling factory at Trenton is still one of the leading contributors to this total.

VIRGINIA GOLD

THE latest gold-mining venture in Virginia, which is reported upon in these pages, will be watched with interest by mining men the nation over. It is a *bona fide* effort, sponsored and conducted by men well fitted by past experience to carry it on. There have been numerous well-intentioned attempts in the past twenty years to make gold mining pay there, but none of them was marked by a procedure of the sort now being practiced.

The current search is not fostered by the desire to winnow a few particles of scattered gold from the surficial deposits that have been thoroughly worked in the past. On the contrary, it is concerned with penetrating below the shallow oxides and with exploring the untapped sulphide horizons which are known to lie underneath. In short, it is a large tonnage of low-grade ore that is sought, rather than scattered pockets of glittering high-grade.

Offhand, there would seem to be plenty of legitimate reason for thinking that paying ore will be developed. The Virginia veins are among the most massive yet discovered, and they are remarkable for their persistence. The mineralized zone extends for more than 60 miles. Individual veins can be followed great distances on the surface. The Fisher lode in Louisa County was opened for a length of five miles by the early operators, who stripped away the richer surface material; and along many other veins the structure can be traced hundreds of feet by means of the pot holes that are still in evidence.

As is usually the case, there is a wide discrepancy when the reported productions o individual mines are added and compared with the mint figures. Some of the difference is attributable to the practice of the English operators of shipping their output to the mother country; but much more of it comes from the all-too common habit of adding a healthy sum each time the subject is mentioned. Thus it is recorded that an area 3 feet square in the Whitehall Mine in Spottsylvania County yielded $160,000 in gold. If this were true, it would well-nigh set a record. The fact remains, however, that Virginia produced a lot of gold, and that the vein system from whence it came gives favorable indications of extending a considerable distance into the earth. Perhaps the shoots are in reality shallow; or, if they do go on down, they may disclose a transformation from auriferous content to the baser metals—copper, lead, and zinc. It is to determine these things that the current deep test is being made.

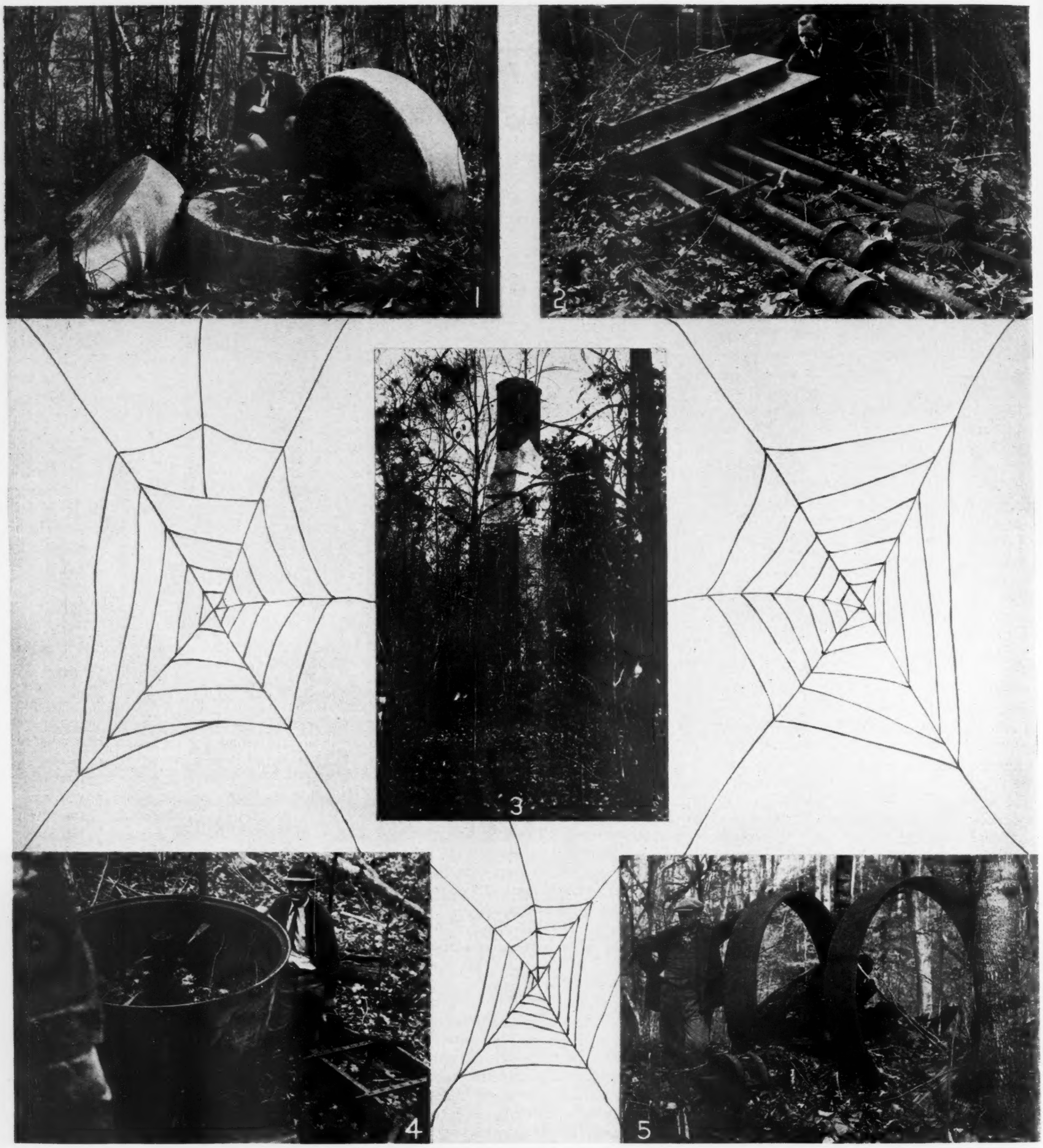
SAFER NIGHT DRIVING

IT SEEMS certain that the bright automobile headlight is doomed for the discard, and with it a large percentage of the highway accidents that occur after dark. Illuminated roadways will make strong driving lights unnecessary in the not far distant future.

Putting the lights along the highways instead of on the cars was suggested many years ago, and several thoroughfares have been thus equipped for experimental purposes. The scheme has heretofore failed of adoption because of the high cost involved and the failure of previously available lighting units to provide satisfactory illumination. Now, however, new sodium-vapor lamps have been developed, and tests indicate that they will give the desired results at very moderate costs.

These new lamps produce a "cold" light free from glare and with a high degree of visibility. Engineers have developed a special glass that is not attacked by sodium vapor, and have introduced improved reflectors that have contours different from those ordinarily used for the purpose of directing light beams. They are made of a specially treated aluminum which has high reflectivity and is very resistant to weathering agencies.

Because more of the energy output of the sodium-vapor lamps is visible light than is the case with incandescent globes of the conventional type, they require less power for a given amount of useful light. In fact, one illuminating engineer predicts that highways can be lighted sufficiently for safe driving on a power expenditure of 2 kw. a mile. The new lamps have been recently installed on four highways in New England and in the State of New York, and are now being applied to flood-lighting a building in New York City.



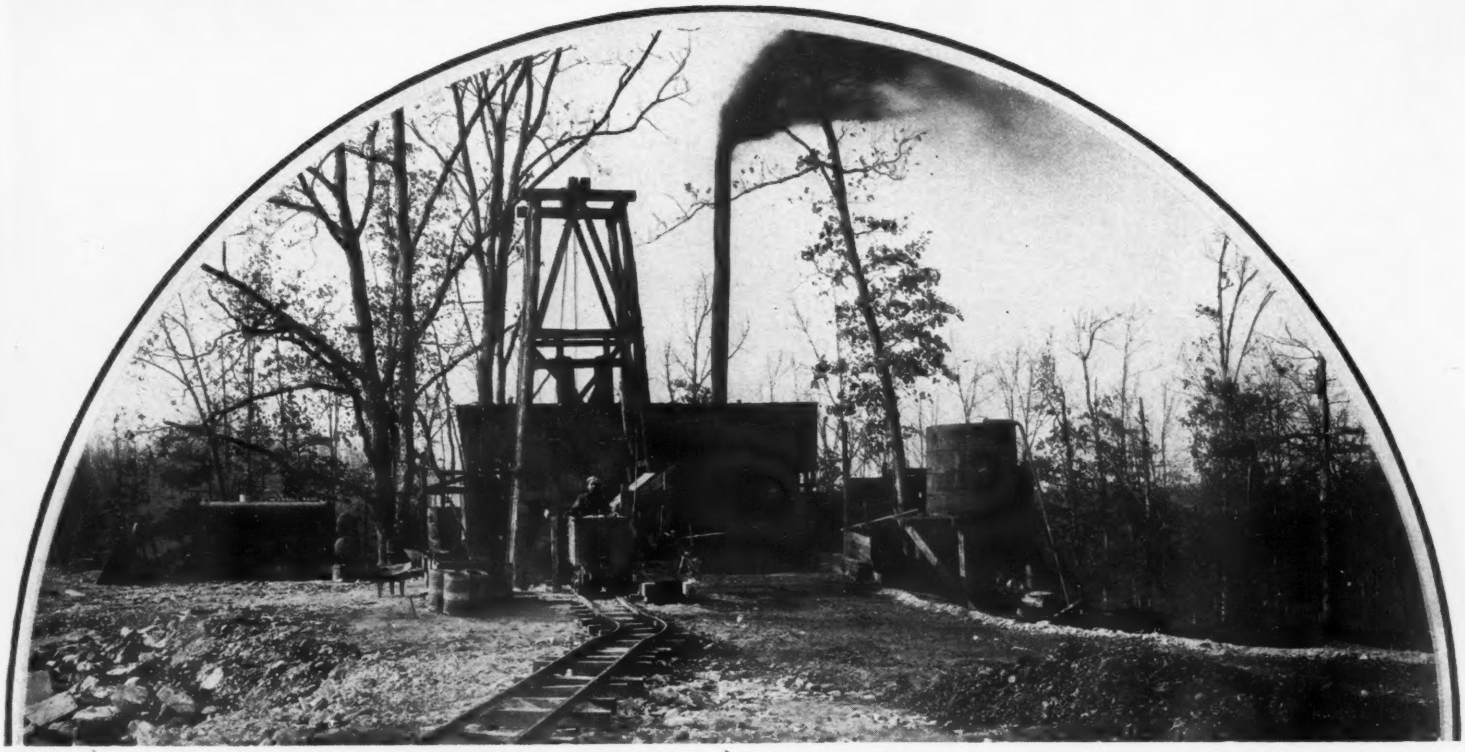
CHATTELS OF A FORMER GOLD BARON

About half a mile from the old Melville workings, on a small stream called Wilderness Run, are the remains of an ore-reduction plant. It was operated by Colonel Stockton, the nation's first mining *entrepreneur*, who seems to have been gifted with the faculty of ferreting out and acquiring a goodly share of the paying prospects. This astute magnate of mines vied with a man named Fisher, who operated in the James River country, for control of the Virginia gold-producing industry.

There are no old workings close to this ruin, and the ores treated there were apparently transported some distance. There is evidence of a dam on Wilderness Run and of a flume leading to an undershot waterwheel, and this source of power is believed to have determined the location of the plant.

The brick stack in picture No. 3 is similar to the Scott furnace still used in the reduction of cinnabar. The ore was fed into it through the door that is visible in the white area near its top. There was a platform there and a housing of some sort, and the ore was trundled up to it on a ramp which ran down at the left but which is now obliterated save for the stone foundations. The fuel for calcining the ore was introduced into two hearths on opposite sides of the base of the structure. That the bricks were made from local clay is established by the fact that they show traces of gold upon panning.

After leaving the furnace, the ore was evidently treated further in stamp mills, chilean mills, *arrastras*, and amalgamating pans. These various types of apparatus, showing the marks of time, are pictured in the positions in which they tumbled when their vulnerable parts decayed and corroded.



SURFACE PLANT OF THE MELVILLE

A small boiler furnishes steam for operating the hoist and a 10x10 Class NF-1 compressor. Auxiliary air is supplied by the 250-cfm., 2-stage, air-cooled portable compressor shown at the left of the building. This unit is used also for prospecting and for miscellaneous purposes. The dump in the foreground is composed of several thousand tons of material which has been taken from the mine for possible future milling. It assays approximately $8 in gold to the ton.

Goldseekers Turn Again to Virginia

C. H. VIVIAN

THE quest for gold has reverted to Virginia, where the yellow metal was first found in this country. After a lapse of nearly 75 years, mining men have returned to the piedmont plain on the eastern flank of the Blue Ridge Mountains to resume explorations that were virtually stopped by the Civil War. The limited amount of recent work thus far done has disclosed promising indications of paying ore deposits. It is too early to draw conclusions, but it is within the realm of possibility that here, within 50 miles of the national capital, a gold field will be born anew. It would be a bit ironical if this should transpire, for during the time these hills have lain almost untouched by pick and drill steel, men have gone to the far ends of the earth in their eager, frantic search for gold.

In his invaluable book, *A History of American Mining*, T. A. Rickard records that when Ponce de Léon landed in Florida in 1573 he was told of an Indian chief who possessed much gold. In 1579 Alvarez de Pineda reported that the natives wore ornaments of gold, which they obtained from the rivers. It was therefore early established that there was gold in this new land. The first explorers learned from the Indians that the yellow flecks came from a region known as Apalache.

For some reason, however, the Spaniards failed to find the source of the metal, although as far back as 1564 one René Laudonnière described the methods used by the natives to win gold in the Apalatcy Mountains. For that matter, the early settlers in this country completely failed to grasp the potential greatness of the mineral resources of the United States. As late as the eighteenth century, the Dutch philosopher, Cornelius de Pauw, wrote that "in all the extent of America there are found but few mines of iron, and these so inferior to those of the old continent that it cannot even be used for nails." Little did he envision that in 1929 the United States would produce more than 56,000,000 tons of steel, all of it derived from native iron ores. The usually prophetic Benjamin Franklin remarked in 1790, when arguing in favor of a paper currency: "Gold and silver are not the produce of North America, which has no mines."

In spite of these early misconceptions of America's mineral wealth, Mr. Rickard informs us that exploration and colonization in both Massachusetts and Virginia were inspired by the belief that those regions harbored precious metals. It is certain that the mother country expected that minerals would be found, for there was a provision in the charter granted in 1606 by James I to the London and Plymouth companies that one-fifth of the precious metals and one-fifteenth of any copper that might be discovered in the colonies should become the property of the crown. When John Smith first bartered with the Indians in Virginia he demanded metals in exchange for his products, and it was only when he could not get them that he was willing to accept furs and fish. Captain Smith is credited with being the first white man to discover gold in this country. That was on the Chickahominy River, a stream that flows into the James River a few miles below Richmond. His find caused much excitement, and soon afterward the colonists collected an entire shipload of glittering dust which they consigned to London jewelers. Those experts took one look at the stuff and recognized it as nothing more than mica.

In his *Notes on Virginia*, Thomas Jefferson mentions the finding, in 1782, on the north bank of the Rappahannock River of a piece of quartz which contained 17 pennyweights of gold. No other gold was ever found at the site, which was about four miles below the present City of Fredericksburg. Mint returns indicate that gold mining started in North Carolina in 1793, and that this state was responsible for all gold produced in the colonies

RELICS OF PRE-CIVIL-WAR OPERATIONS

The massiveness of the stack at the right indicates that a sizable steam plant was used by the operators of the Melville 75 or more years ago. The structure which appears to be a boiler has no firebox, and is believed to have been utilized for drying concentrates. Between the two human figures can be seen a small millstone which probably served for grinding flour rather than ore.

Two interesting implements are illustrated above. Partly buried in the ground is a solid iron cylinder that was evidently employed in the ore-grinding process. Its original longitudinal corrugations have been completely worn away in the central area and replaced with circumferential striations, showing that it was extensively used. It was probably suspended by an arm, cast integral with it, of which a portion can be seen at the left where it enters the ground. Such a mounting would provide a pendulumlike action that would serve to crush the ore between the cylinder and another metallic surface. The implement lying across the cylinder is a pipe-threading die. Its long handles indicate that it was designed for operation by two or more men. Much of the early mining in this section was done by the British; and it is believed that most of the iron structures came from England.

prior to 1829. The total output for those 36 years was valued at $110,000. Virginia began producing in 1829, and in the same year America experienced its first real gold rush in Georgia. Virginia, the Carolinas, and Georgia yielded about $1,000,000 worth of gold in both 1833 and 1834.

The first incorporated gold-mining company in Virginia was the Virginia Mining Company of New York, which operated between 1830 and 1843 on five acres of land near St. Justs in Orange County under a 20-year lease. The highest annual production recorded was $101,000 in 1833. A half interest in the lease is reported to have sold for $30,000, a transaction which was perhaps the nation's first exchange of a mining property for money. The Virginia company sold its interests in 1843 to the Chancellorsville Mining Company, of England, which was in operation until near the time of the Civil War.

Following the initial discovery of ore in place, other finds of gold were made in rapid succession within an area lying mostly between the Rappahannock and the Potomac rivers and having extreme dimensions of 60x20 miles. Of triangular shape, it includes all or portions of seven Virginia counties. From 1832 until the war broke out, extensive operations were carried on throughout this section. Official government figures, based on mint returns, place the all-time gold production of Virginia at $3,298,436, of which all but about $200,000 worth was obtained prior to 1880. There is reason to believe, however, that these figures do not tell the whole story. Following their traditional propensity for gold-mining operations, the British interested themselves in many of the Virginia mines in the early days, and there is substantial basis for the belief that they sent a considerable share of their output direct to England. Mining men that have investigated the extent of the old workings and some of the stories concerning the richness of individual deposits are inclined to believe that the actual production in Virginia was materially greater than indicated in the United States official tabulation.

The initial operations were confined to surficial deposits. The almost vertical gold-bearing ledges formed outcroppings which could be traced without difficulty for distances of several hundred feet. The gold occurred as free metal, or in such mechanical combinations with iron pyrites and other vein materials as to constitute an easy milling ore. Mining was carried on in open pits or through vertical shafts. The average value of the ore probably was fairly low, but there are persistent legends of occasional rich pockets. These stories ascribe such tremendous values to some of the finds that they are patently exaggerated, but most of them apparently have some reason for being. At any event, there must have been a fair measure of profit in the operations to warrant the amount of digging that was done.

Labor was inexpensive. Slaves were largely employed, and these were paid 50 cents a day. The total mining expenses were oftentimes not more than $1 a ton. Few contemporary accounts of these operations have come down to us; but from those that are available it is clear that a fair-sized mine in which as many as 25 men were at work could be run at a cost of as little as $125 a week.

So long as they were in the shallow zone, where oxidized ores occurred, these pioneer miners experienced little difficulty in extracting the contained gold from the rock, although their methods and technique permitted of losses which would be considered highly wasteful under present metallurgical practices. The usual procedure was to crush the ore by means of stamps, or in Chilean mills, and then to amalgamate the gold thus freed with mercury. In some cases the ore was calcined prior to such treatment. Considerable amalgam excaped from the equipment, as is proved by the fact that it is easy even at the present time to find scattered bits of it by digging in the areas below the sites of the old mills.

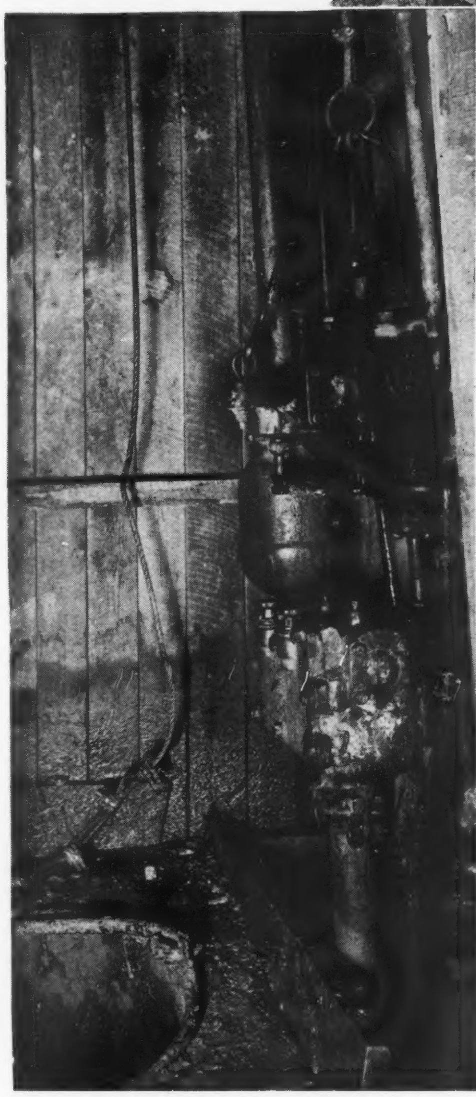
A combination of circumstances closed down the Virginia gold mines. During the latter years of their operation, oxidized ores became scarcer all the while, and the sulphide ores encountered with increasing depth could not be satisfactorily treated for the recovery of their gold content. Water also became a problem, and its handling measurably in-

creased mining costs. Almost without exception, operations ceased at depths of around 100 feet, although reports have it that in one or two instances they were carried downward as far as 200 feet. The gold strikes in California, in 1848, undoubtedly caused many of the Virginia miners to forsake their field for the fabulously rich new territory in the West. These factors had probably diminished operations by 1861; and with the outbreak of the Civil War a definite halt was called. When the fighting was over, inexpensive labor was no longer available, and operations were never resumed on their former scale.

During the intervening years there has been some sporadic mining in Virginia. "Pocket hunters" have been able to eke out a living by patiently searching for remnants of larger surface deposits overlooked by the early operators. Throughout the region it is possible to obtain gold by panning in any of the streams or gulches, and now and then a few individuals have followed this somewhat precarious calling. Some attempts have been made to open up old workings, but none of these has been adequately financed and hardly any have been carried on by men thoroughly experienced in mining. At no time has a move been made to prospect the deeper rock to learn definitely whether the ores persist far below the surface and, if so, to ascertain their character. Surface examinations are handicapped by the fact that most of the ground is covered with vegetation so dense that it is virtually impossible, except in the winter months, for a human being to get through it. This circumstance, together with the caved condition of the old workings, makes it extremely difficult to gather information of any value without considerable digging.

A few months ago, however, an enterprise was launched which promises to determine what lies below these abandoned excavations. Upon its outcome depends, in large part, the future of Virginia gold mining. Should success attend these efforts, old workings in that state and in the Carolinas would, without question, feel the touch of drill steel and powder, and the Appalachian chain, in which America's infant gold-mining industry was cradled, would once more experience a rush of fortune seekers. Such a rush would be a tame affair, however, compared with those which America has seen in the past. All the land is patented, and no claims could be filed. Owners of the ground, or those to whom they granted leases or other concessions, would be the only ones to benefit.

The venture just mentioned is being carried on by the Rapidan Gold Corporation, which is organized under the laws of Virginia. It is directed by experienced mining men who, though fully aware of the uncertainties that attend the search for gold, are convinced that this section of the country, which has been overlooked for three-quarters of a century, warrants thorough probing. The company moved quietly until it had purchased tracts which seemed the most promising, and then hauled in essential prospecting equipment and engaged in systematically exploring one of the old mines, starting at the level where its former owners ceased work. The scene of operations is the old Melville Mine about eighteen miles from Fredericksburg. This section is in the heart of



OPERATIONS IN THE MINE

All drilling thus far done has been carried on with one S-68 wet-type "Jackhamer" (above). Twelve 6-foot holes constitute a round. Three changes of steel are made for each hole. The average drilling time per round is two hours. Blasting is done with 40 per cent dynamite. Each round advances the face about 5 feet. By alternating mucking and drilling in two headings, it is possible to make 10 feet of progress a day with one shift. The lower view shows the shaft at the working level with a bucket ready to receive the ore, which is handtrammed in cars. When this old shaft was opened, a Cornish pump was found in it. This has been replaced with the modern, efficient Cameron sinker pump shown.

The Wilderness, a name which was applied to it nearly two centuries ago after Gov. Alexander Spotswood had cleared it of timber to supply fuel for several nearby iron furnaces, and the resulting forest of stumps had become heavily overgrown.

The company has acquired 1,000 acres through which old workings on the Melville vein system can be traced for 8,000 feet southward from the Rapidan River. Across the Rapidan to the north is the old Culpepper Mine, a steady producer for 30 years prior to the Civil War. In recent months the company purchased 200 acres abutting the Melville tract on the west and containing the Great Vaucluse Mine which once was probably the best known mine in Virginia. Options have also been obtained on several other tracts.

The Great Vaucluse was opened in 1832, and eleven years later had a plant valued at $70,000. It was purchased along with the Grymes Mine, in 1854, by the Liberty Mining Company of England for $250,000. Prior to 1852 the mine was worked by two open cuts 120x75 feet in surface dimensions and 60 feet deep. It is recorded that 50 tons of ore was being mined and crushed there daily in 1853. This is one of the few old Virginia mines concerning which an authoritative account is available, and mining men will probably be interested in the following description of its equipment from *Gold Mining in North Carolina* by H. B. C. Nitze and H. A. J. Wilkens:

"The machinery consists of a condensing Cornish mining engine of 120 horsepower; the mill-house contains 6 large Chilean mills; the cast-iron bed-plate of each is 5 feet 6 inches in diameter, and on it are two cast-iron runners of the same diameter, the total weight of the mill being 6,200 pounds. The ores, on arriving at the surface, are divided into two classes: 1. The coarse and hard ore for the stamps: 2.

PLACER OPERATIONS

This machine was improvised to treat the blue clay which is the prevailing surface material in the gulches. The dirt and water are fed together into the revolving cylinder, where the clay is broken up so as to release the contained metal. The larger stones are discharged at the end of the cylinder, while the fine material is laundered to two Ainley centrifugal bowls where the values are caught. The machine is operated by a gasoline engine. The excavator shown is a Universal ¾-yard shovel. About 65 cubic yards of dirt a day can be washed with this equipment. Much of the gold recovered is in the form of amalgam, which escaped from the old mills and was carried into the gulches by water.

Slate and fine ore for the Chilean mills. This is done by means of a large screen. The very large pieces are first broken by a hammer before they are fed to the stamps. All of the ores are ground with water, each mill being supplied with hot and cold water at pleasure. Twelve inches from the top of the bed-plate there is a wide, open mouth, from which the turbid water escapes to tanks. On the south side of the steam engine is the stamp house and amalgamation mill, containing 6 batteries of 3 stamps each: these stamps with the iron head of 125 pounds weigh 350 to 380 pounds each. Each battery is supplied with water, and at each blow of the stamp a portion of the fine ore passes out of the boxes through the grates to the amalgamation room. Here are stationed 18 small amalgamation bowls of cast iron, 30 inches in diameter. The bowls are supplied with runners which move horizontally; in the center of these runners is an eye or opening like that in the runner of a corn mill. The ground or finely stamped ore, gold and water pass into this eye, and by the rotary motion of the same are brought into contact with the quicksilver deposited in the center, forming amalgam. From the amalgamators, the pulp passes through 3 dolly-tubs or catch-alls, acting as mercury and gold tubs. After this the whole mass passes to the strikes or inclined planes, where the sulphurets are deposited and the earthy matter is washed away. These sulphurets were formerly treated in two heavy Mexican drags or *arrastras*, but not answering so good a purpose they have been altered into three heavy Chilean mills."

Of further interest is the fact that much of this equipment has been preserved for posterity. A few years ago the property was acquired by Judge A. T. Embrey of Fredericksburg, who desired it for the production of timber. One day in 1931 a man, who identified himself as H. B. English, a Washington attorney, approached Judge Embrey with an offer to buy the Vaucluse machinery and to remove it. Judge Embrey replied that the small sum tendered him was not sufficient to pay for the damage that would be done to his logging roads in transporting the heavy loads that would be involved. Mr. English thereupon stated that, if a satisfactory price for the 200-acre tract could be agreed upon, he would buy the land and all. An agreement was reached and a contract drawn. When the deed was later presented for his signature, Judge Embrey learned that he had sold his property to Henry Ford. The machinery is now in Mr. Ford's museum in Dearborn.

The land remained idle, but it was felt that the Detroit manufacturer would eventually utilize it, particularly as it was known to contain deposits of iron pyrites which could be made to yield products of use to his enterprises. This belief was strengthened by the fact that he had informed inquirers several times that it was not for sale. Accordingly, when the officials of the Rapidan Gold Corporation decided that they would like to add it to their holdings, they had scant hope of obtaining it. A personal visit to Mr. Ford to explain the purpose for which the land was wanted was decided upon as the best course. The president of the corporation, Moritz Norden, elected to make the trip to Detroit. He was received by Mr. Ford, and when the latter was told that the mining operations were already giving work to more than twenty men and that, if they were successful, they would add materially to Virginia's resources, the automobile manufacturer readily assented to sell the property for just what it had cost him.

Mr. Norden is primarily responsible for the present operations. He received his education as a mining engineer in his native land of Germany, and soon afterward came to this country. Ever since he has engaged in mining ventures in the western part of the United States and in Mexico. These activities had to do not only with gold and silver but also with the commoner base minerals. He likewise did considerable work with beryllium, barium, and similar elements. It was while he was interested in a cinnabar property in Arkansas that his attention was called to the old Virginia gold belt. He resolved to visit the section and to make some investigations. For a number of months he tramped through The Wilderness examining outcrops, inspecting the old workings, panning the dirt in the gulches, and making a general survey of the geology of the region. Encouraged by his findings, he organized the Rapidan Gold Corporation and secured adequate finances for carrying out a definite program of development calculated to determine the character of the ores underneath the oxidized zone exploited by the former operators. C. Hyde Lewis, who had been associated with Mr. Norden in the cinnabar operations in Arkansas and who had previously had a wide experience in Bisbee, Ariz., and other mining districts of the West, joined the new organization as general manager.

Fundamentally, the geological conditions are considered very favorable to the occurrence of extensive ore bodies. The vein system is in pre-Cambrian rock of igneous origin—a condition which obtains in virtually all the better-known gold fields of the world. During the one or more mountain-forming movements to which the region was subjected, enormous pressures were exerted from the east, and their cumulative effect was a series of thrust faults paralleling the Blue Ridge range. This fault system is similar to that in the Mother Lode district in California. At various points are dikes of diabase—intrusions which are believed to have furnished the heat necessary for the vein-forming processes. Other igneous rocks occur together with a considerable succession of sedimentary deposits. Heat and structural movements have metamorphosed many of these to such an extent that their original characters are sometimes hard to determine.

The pre-Cambrian base in which the veins are found were most probably granites at one time, although now they exhibit a decidedly foliated structure and are classed under the heading of gneisses and schists. There are present, then, all the elements usually existing in regions of extensive mineralization. There are abundant indications that the veins are of the true fissure type: they are massive, and are traceable for great distances on the surface. A working rule which geologists have generally found to be applicable to such veins is that their depth will be at least equal to their surface length. If this be true in this instance, then the ore bodies will have depths of hundreds if not thousands of feet. Some experts that have examined this area in years past hold that the veins now exposed are merely stumps or roots—in other words, remnants of

once great mineralized intrusions whose upper portions have been eroded away in bygone ages. Determination of the true conditions can be made, of course, only through intelligent and thorough prospecting of the deeper levels, and this is the purpose of the Rapidan Gold Corporation.

Operations thus far have been confined to the Melville. Advantage was taken of the existence of an old shaft, which had been sunk to a depth of approximately 100 feet, as a starting point for the work. This shaft was deepened to provide a sump 125 feet below the surface. A level was cut at 112 feet where the former operators had barely started to drift when they laid down their tools for all time. The vein at this point is nearly vertical, having a dip of 83°. The shaft is in the country rock on the hanging-wall side of the vein, which necessitated driving a few feet to get into the mineralized area. The vein is approximately 30 feet wide. On both edges are bands of quartz, from 2 to 4 feet in width, which are considerably richer than the middle portion. Stringers of iron pyrites, sometimes 5 or 6 inches wide, are common in these hanging-wall and footwall bands.

Drifts are being run on opposite sides of the vein and in both directions from a central crosscut. At intervals of about 100 feet, crosscuts will be made to connect these two drifts. By following this procedure it will be possible to determine the value not only of the rich part but also of the whole vein. The dimensions of the vein are such as to give hope that it will yield a big tonnage of milling-grade ore; and the development work is being conducted with that in view. If the full width of the vein is too lean to show profits, there still remains the possibility of mining lesser quantities of higher-grade ore from the two outer bands. This assays from one to several ounces of gold to the ton.

Up to the present time more than 500 feet of underground work has been done. No effort has been made to ship any of the ore; but a careful record has been kept of the values of all the material excavated. Assay equipment has been installed on the property for this purpose. Samples are taken in the mine after each shot, and check samples are taken from every bucket of ore hoisted to the surface. The richer ore is sorted and piled separately, while the other is dumped for possible future milling. This dump, now containing several thousand tons of material, has an average value of around $3 per ton.

In recent weeks a second shaft, 150 feet from the first, has been sunk and connection made with the workings on the 112-foot level—this shaft is now being deepened another 100 feet. It has two compartments, a 50-foot headframe, and a 120-ton ore bin. Plans are also being made to sink a shaft at the Great Vaucluse property.

Two diesel-engine generator sets, one of 120-hp. and the other of 240-hp., are now being installed. A 60-ton pilot mill of the flotation type will be built near the new shaft. Tests show that the ore floats fast and that a good recovery can be made at 40 mesh. The ratio of concentration is about 30 to 1. The plant equipment will include a 6-foot by 22-inch Hardinge mill, a Dorr classifier, Denver Equipment Company "Sub A" flotation cells, and an Ingersoll-Rand 310-cfm., direct-connected, motor-driven compressor.

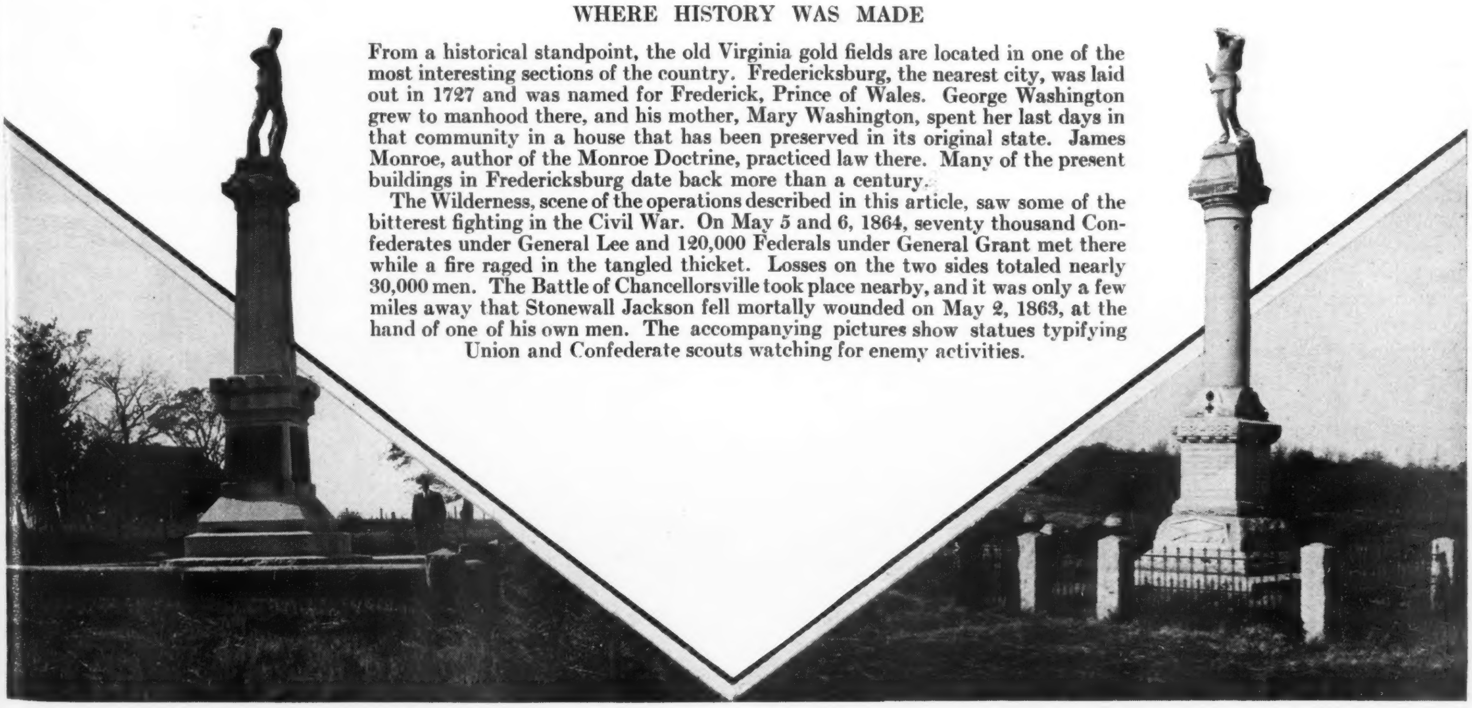
It is expected that the mill will be in operation by the end of March, at which time ore from the deeper level will be available. At the present time the ores represent a transition between the oxidized and sulphide zones. Thus far, little copper has been disclosed and no lead or zinc. The copper is mostly in the form of chalcopyrite, with some bornite.

The work of opening up the Melville disclosed interesting information as to the manner in which mining was done 75 years ago. An old Cornish pump, which had an 8-foot stroke, was in the shaft. Some of the rubber gaskets with which it was fitted were found to be in serviceable condition despite their long exposure to air and water. The old drill holes in the workings gave evidence that for their hand drilling the miners employed 1½-inch-diameter steel. The average round gave an advance of about 2 feet. Black powder was used for blasting.

In addition to the underground work, the company is conducting small-scale placer operations in a gulch below the Melville Mine. These activities are showing a profit; and a survey of the material available for working indicates that a total of approximately $50,000 worth of gold will be recovered in this manner if the present value per cubic yard of dirt is maintained. Much of this gold is in the form of amalgam which escaped from the old mills. At times considerable pockets of this material are encountered in spots where conditions were favorable for its concentration by running water. The native gold is ordinarily found admixed with a stiff blue clay. Balls of this clay must be broken down in order to segregate the gold particles; and the placer machine in use has been designed to accomplish this.

Physical conditions for economical mining and milling are excellent at this location. The climate is such as to permit of all-year operations. Improved highways run virtually past the properties. There is abundant water for milling; coal can be easily obtained; and adequate shipping facilities are close at hand.

Much interest is being manifested in this belated endeavor to awaken the Virginia gold fields into new activity; and men prominent in the gold-mining industry have visited the scene. These authorities are agreed that this treasure hunt has a good chance of success. At least the Rapidan Gold Corporation, through its thorough and extensive work, is on its way towards obtaining a conclusive answer to the question of whether or not prospectors have been unnecessarily traveling the byways of the earth in their search for the elusive yellow metal.



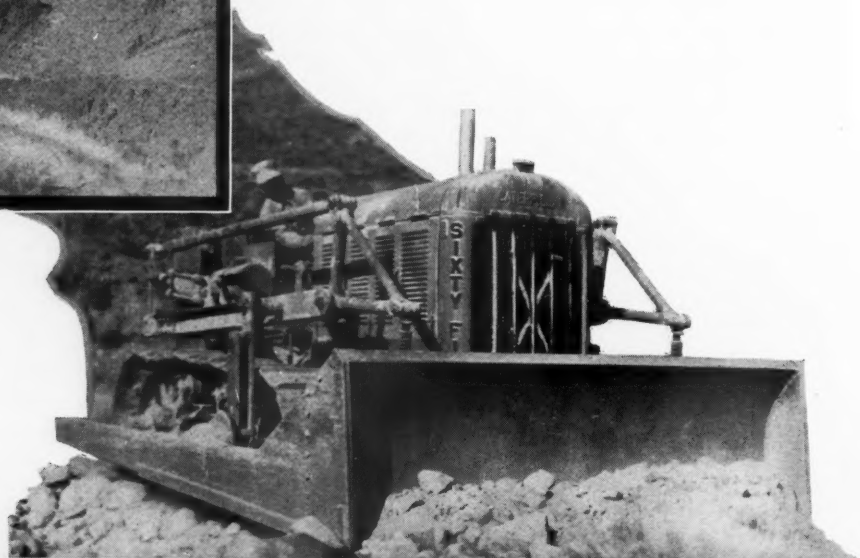
WHERE HISTORY WAS MADE

From a historical standpoint, the old Virginia gold fields are located in one of the most interesting sections of the country. Fredericksburg, the nearest city, was laid out in 1727 and was named for Frederick, Prince of Wales. George Washington grew to manhood there, and his mother, Mary Washington, spent her last days in that community in a house that has been preserved in its original state. James Monroe, author of the Monroe Doctrine, practiced law there. Many of the present buildings in Fredericksburg date back more than a century.

The Wilderness, scene of the operations described in this article, saw some of the bitterest fighting in the Civil War. On May 5 and 6, 1864, seventy thousand Confederates under General Lee and 120,000 Federals under General Grant met there while a fire raged in the tangled thicket. Losses on the two sides totaled nearly 30,000 men. The Battle of Chancellorsville took place nearby, and it was only a few miles away that Stonewall Jackson fell mortally wounded on May 2, 1863, at the hand of one of his own men. The accompanying pictures show statues typifying Union and Confederate scouts watching for enemy activities.

Los Angeles Prepares to Use Boulder Dam Power

LAWRENCE A. LUTHER



RUGGED ARIDITY

Much of the region being traversed is desert waste, with alternating plains and mountain ranges. The first step in the construction of the transmission line was the building of roads over which materials and equipment could be moved. Where rock occurred, portable compressors and "Jackhamers" (bottom) were indispensable agencies in carving the highways. In softer material, bulldozers mounted on Caterpillar tractors did the job (center). The top picture shows a partly completed road winding down a mountainside from Beerbottle Pass, near Jean, Nev. In the middle distance, between the two ranges, is a typical dry lake of the desert.

OUR great deserts of the Southwest are still in process of transition from feared, often deadly, wastes to well-mapped and much-traveled areas. Excessive heat and lack of water, from the days of the first pioneer on through recent times, have not only taken a heavy toll in life but also impaired the health of men who have left beaten trails in search of wealth. Though they may never be conquered, the deserts have been, at least, subdued; and now an excellent highway from Salt Lake City to Los Angeles crosses the trails of intrepid prospectors and the rutted roads of Borax Smith's 20-mule-team wagons. Beacons mark the air lanes; and a low-flying plane, visible for many miles in the rare desert air, conspires with numerous gas stations along the road to dispel any sense of isolation. Even Death Valley has been tied to civilization by passable roads; and a smart resort caters to vacationists seeking solitude and matchless sunsets.

Before the electric current that is to be generated by the turbines at Boulder Dam can reach the centers of population in Southern California, it has to be carried for 230 miles through this great waste to a crossing of the San Bernardino Mountains near Cajon Pass, gateway from the desert to the vast garden that is Southern California. Demand for large blocks of the power there to be produced was essential to the financing of the Boulder Canyon Project; and the importance of the part played in this respect by the City of Los Angeles—which will be Uncle Sam's leading customer in that territory—is best expressed in the words of Ray Lyman Wilbur, former secretary of the U. S. Department of the Interior: "If you had not built up your municipal bureau of power and light as a going concern with sound resources, the Boulder Dam appropriation would not have been made." The Bureau of Power and Light of this largest city in the West now has the construction of a transmission line to Boulder Dam well underway.

Federal allocation of power gives Los Angeles 14.905 per cent of the plant's output of "firm" power. As laymen, we may be able to get an idea of what this figure means when it is recalled that it is to be the world's largest hydro-electric station, its closest rival being the great Russian plant at Dnieprostroy. It will have a capacity of 1,835,000 hp., as contrasted with the Niagara Falls plant on the American side of the river which produces 453,500 hp., and with the Muscle Shoals plant which is to have an ultimate output of 600,000 hp. The total firm power to be generated at Boulder Dam—power that is already allocated—is calculated at 4,240,000,000 kwhr. per

year, and the secondary or unallocated power at 1,550,000,000 kwhr. The output, however, will be decreased gradually on account of silting up of the reservoir and further developments to be made upstream.

The transmission line now building will be 270 miles long, and it is estimated to cost $22,800,000. The line, itself, will represent an outlay of $15,700,000, while the remaining sum of $7,100,000 will be spent on necessary terminal facilities and on other appurtenant structures. A loan from the Federal Reconstruction Finance Corporation has been negotiated for the full amount—the people of the City of Los Angeles having, in 1927, decided by referendum to participate in water and power to be developed by the Boulder Canyon Project. It has been estimated that this loan can be paid within ten years from the normal revenues of the municipal Bureau of Power and Light. Work was started on the line in June of 1933, and the expectations are that it will be in operation in September of 1935.

At that time some of the large generators that are to be installed in the power houses probably will be ready for service. Orders for four of them have been placed, two with the Westinghouse Electric & Manufacturing Company, of Pittsburgh, Pa., and two with the General Electric Company, Schenectady, N. Y. Each of these generators, which are now in course of construction, is rated at 82,500 kva. and, because of the special problems encountered in the transmission of power over so long a distance, incorporates special features that will make it equivalent in size to a generator having a capacity of approximately 125,000 kva. and possessing normal characteristics. Just what these units represent in magnitude can perhaps be grasped when it is understood that each will have an over-all diameter of 40 feet, a height of 32 feet, will weigh more than 1,000 tons, and—including its regulator, surface air coolers, and exciters—will require at least 40 freight cars for its transportation.

A thousand or more men will be employed throughout much of the construction period, and they will have to work at widely separated locations, many of them remote from established routes of communication. In making the plans for this far-flung organization, it was recognized that the field forces would have to be provided with the best of living quarters and facilities. Climatic conditions in that region during much of the fall, winter, and spring leave little to be desired—the nights being cool and the days invigorating; but the work must be carried on throughout the summer months, with their intense heat, and also during occasional periods of severely cold weather in the winter time. In building and equipping the seven camps along the line between the dam and Cajon Pass, these facts have been borne in mind, and they are therefore the last word in comfort and in sanitation. The latter system is much like that obtaining in permanent military cantonments.

Toiling as they must for the better part of the year in the sun, the men have to endure temperatures sometimes exceeding 135°F.; and, demonstrating the theory of refrigeration by evaporation, they consume individually anywhere from 3 to 5 gallons of water daily. The numerous shower baths and the modern plumbing that are features of the camps also call for an abundance of water. Fortunately, adequate supplies have been obtained without much difficulty at the different sites by drilling wells to depths ranging from 250 to 500 feet.

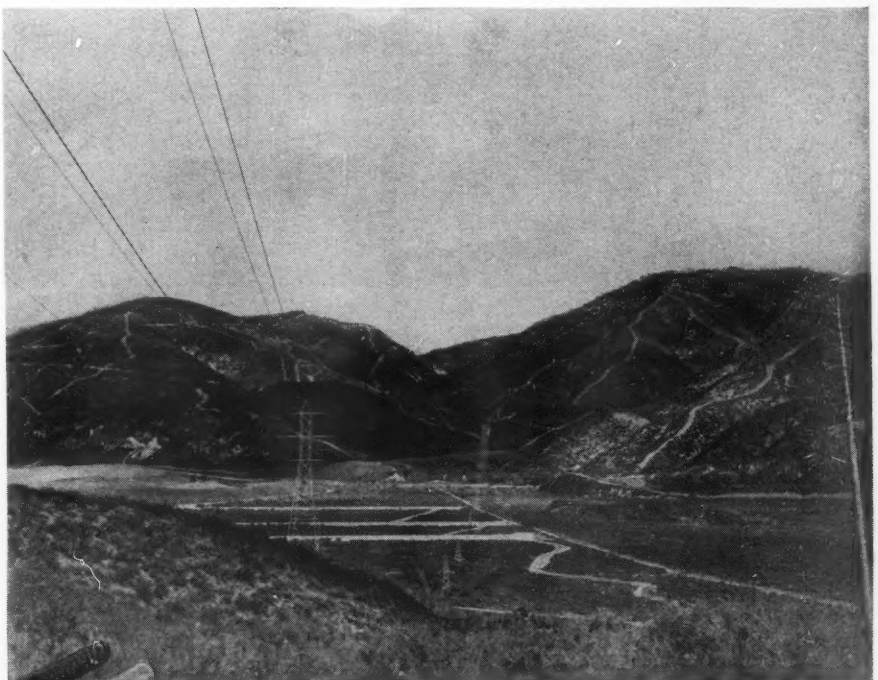
Cooking facilities compare favorably with those found in first-class hotels; and breadstuffs are turned out fresh daily in modern bakeshops. The food provided is sufficiently varied so that the men can select the particular diets that best agree with them. In each camp there is a mechanical refrigerating plant that has a capacity of 300 pounds of ice per day. It is designed also to furnish chilled water and to maintain a temperature of 38°F. in the meat compartments and of 45° in the fruit and vegetable compartments. Both of the latter are served in abundance because of their recognized value as hot-weather foodstuffs. Cold storage is supplemented by cellars in which edible roots are kept. Employees are charged at the rate of 40 cents a meal and ten cents per day for housing.

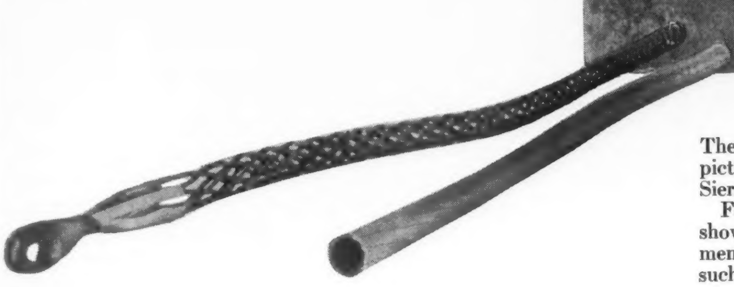
Electric power being available at one of the camps, it is equipped with a complete electric kitchen. With that exception, propane-butane gas producers are in service and supply fuel for both cooking and heating. Gasoline-motor-driven plants generate current for lighting, which compares favorably with that found in the average home.

The administrative headquarters have been established at Yermo; and wherever the distance from existing telephone lines has made the cost of such connections prohibitive, wireless telegraph sets have been installed as a means of communication between those camps and headquarters. The sets use a LeBell transmitter, operating on 90 meters or 3,332 kilocycles, and a National receiver. Those in charge of the instruments are licensed by the Federal Radio Commission.

In view of the rigorous climatic conditions under which the work must be done for considerable periods each year, the physical requirements of the men hired for the job were made unusually exacting. Every precaution is taken to safeguard their health; and ambulances, each staffed by a doctor and a registered nurse, are assigned to the Silver Lake Camp, on the Death Valley Road out of Baker, and to headquarters.

Roads to some of the more isolated camps along the line of construction—more than 200 miles in extent—were of first consideration. The terrain over which they have been built





MOUNTAIN BARRIER AND TYPE OF CONDUCTOR

The new 270-mile line will cross the San Bernardino Mountains, which are pictured here at the point where one of the existing lines of the Southern Sierras Power Company passes over them at Cajon Pass.

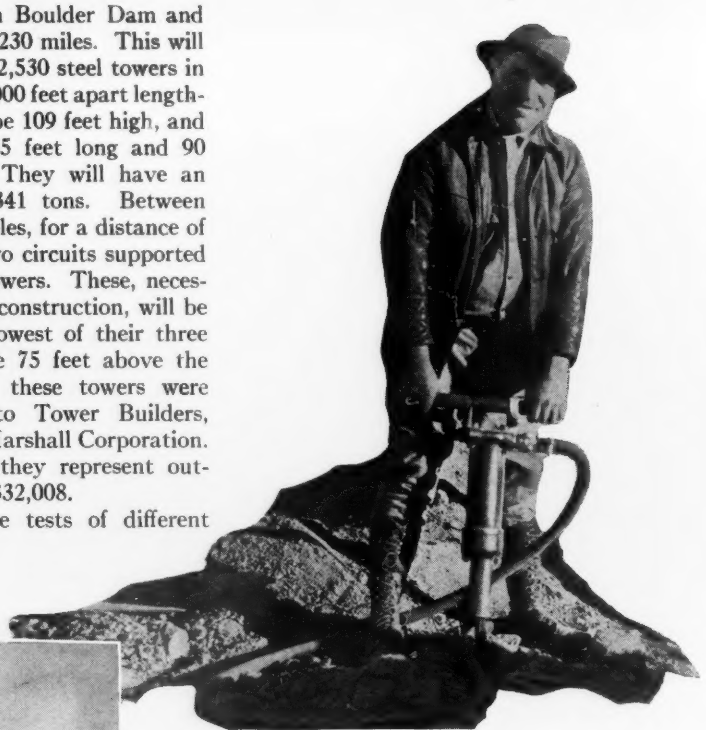
Following extensive tests, the Heddernheim type of power conductor, shown at the left, was selected. It is composed of interlocking spiral segments of copper, and is 1.4 inches in diameter. Beside it is a braided grip such as will be used in drawing the conductor during construction.

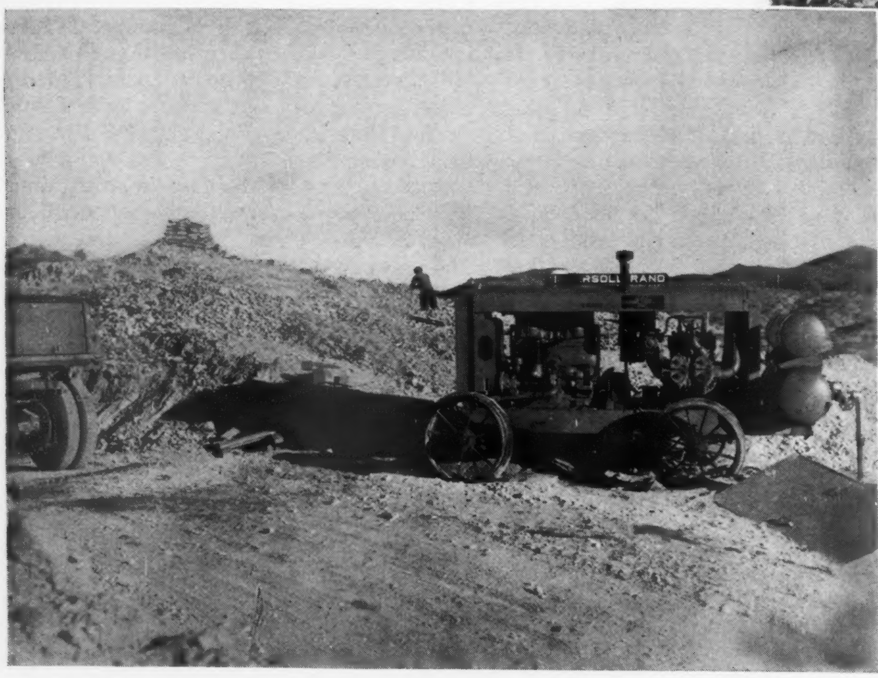
ranges from the smooth floors of what were once lakes in the desert—nature's ready-paved speedways—to steep and relatively high mountain chains. In this work, Caterpillar tractors equipped with Master bulldozers were used for leveling the roadways. In sections where rock was encountered, the material was drilled with air-operated "Jackhamers" and shot sufficiently to excavate a terraced shelf or to make a fill across a ravine. Certain short stretches were almost 100 per cent rock, and these required a top dressing of finer material.

Year-round service in this hottest of our desert areas will, as may be expected, test the machinery employed just as much as it will the men. Relatively high altitudes and abnormally high intake temperatures combine to cause peculiarly difficult conditions, and with these the portable compressors, especially, have to cope. But the 2-stage units on the job, with their fan-cooled air intercooler between stages, are equal to the situation and operate with efficiency. This type of compressor is well adapted for mountain road-building because of its compactness and comparative lightness; and where gasoline must be hauled long distances by truck, as in this particular case, the low ratio of fuel consumed to air delivered is of decided advantage aside from the monetary savings effected. One or two of these Ingersoll-Rand Type 40 portables, with a displacement of 250 cfm., are now stationed at the several camps where they supply air primarily for paving breakers. Also at each camp there is a fully equipped shop for the repair and maintenance of all the machinery in use.

To lessen the hazards incident to severe electrical storms common to the desert, two rows of towers, each carrying a single circuit, are to be erected between Boulder Dam and Cajon Pass—a stretch of 230 miles. This will involve the setting up of 2,530 steel towers in pairs and spaced 800 to 1,000 feet apart lengthwise. Each of these will be 109 feet high, and will support crossarms 65 feet long and 90 feet from the ground. They will have an aggregate weight of 23,341 tons. Between Cajon Pass and Los Angeles, for a distance of 40 miles, there will be two circuits supported by a single line of 271 towers. These, necessarily, will be of heavier construction, will be 144 feet high, and the lowest of their three 39-foot crossarms will be 75 feet above the ground. Contracts for these towers were awarded, respectively, to Tower Builders, Inc., and to McClintic-Marshall Corporation. In the order mentioned, they represent outlays of $1,957,737 and $332,008.

A series of exhaustive tests of different kinds of power conductors was made in the Ryan Laboratory of Stanford University before the Heddernheim type was selected. This is a hollow-core copper tube made up of interlocking spiral segments, and has an outside diameter of 1.4 inches—the largest of the type ever to be put to use in this country. Its inherent superiority lies in the fact that it not only has an area sufficiently large to carry the electrical and mechanical loads involved but also a diameter adequate to minimize the corona losses. Also, by virtue of its lightness, as compared with the other conductors examined, it effects material economies in the supporting structures. The contract for this material—for 1,626 miles of copper conductor —was awarded to the General Cable Corporation, and amounts to $2,399,000. At normal load, the total line losses, including transformers and synchronous condensers, are calculated at approximately 9 per cent. Current will be carried at a receiver-end voltage of 275,000, with 287,000 volts at the sending end. This represents a distinct increase in electrical transmission, as the highest voltages heretofore sent over long lines in the United States and abroad has not exceeded between 220,000 and 230,000 volts.



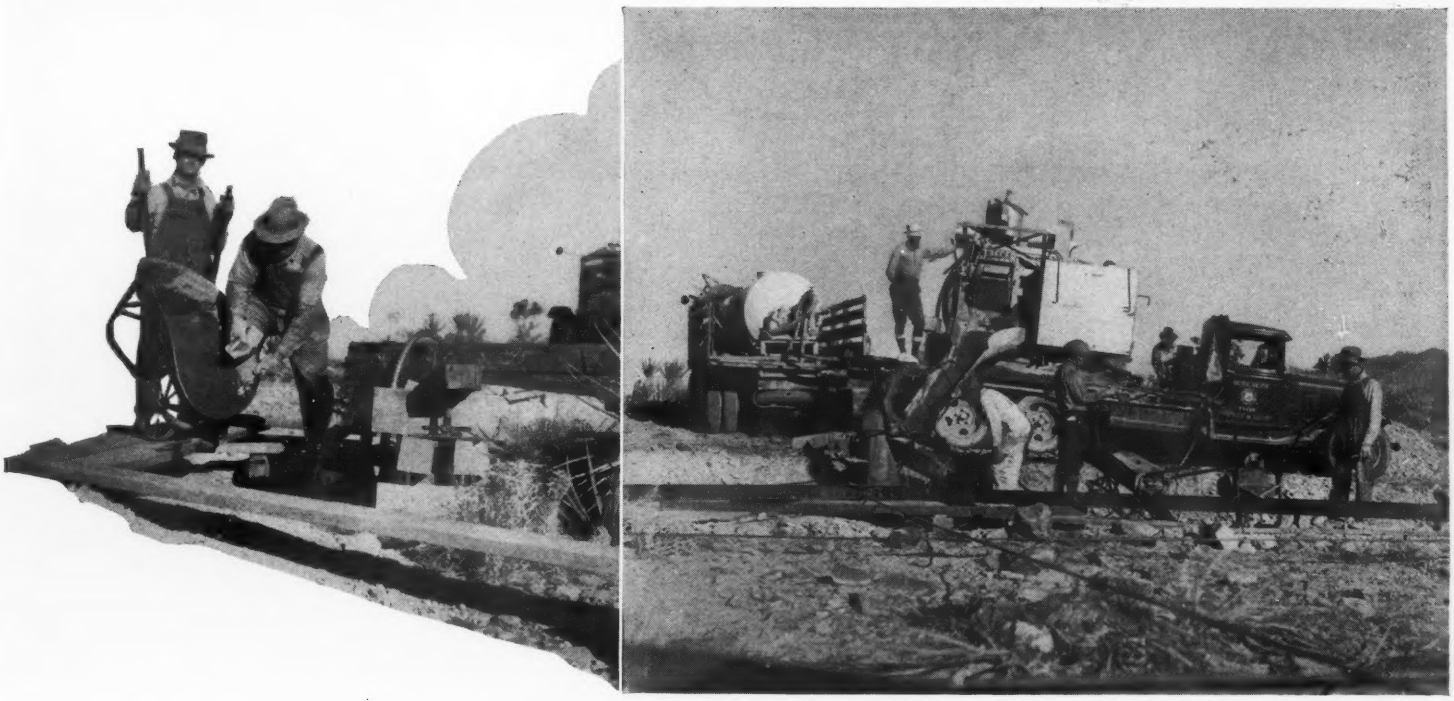


EXCAVATING TOWER FOOTINGS

Steel towers, 109 and 144 feet high, will support the line. The tower legs will be embedded in concrete foundations poured in excavations 7 to 10 feet deep. Most of the ground is soft enough to be dug without blasting. Light-weight paving breakers serve admirably for this purpose. Air for operating them is supplied by 2-stage, air-cooled portable compressors which are particularly well suited to withstand the terrific desert heat that prevails during several months of the year.

The single-circuit or eastern section will be protected by an overhead ground wire of ½-inch galvanized steel. This will be strung, in each case, above the power conductors and at the top of the towers. This kind of wire was considered adequate because the relatively clean atmospheric conditions prevailing in that desert region are such as not to cause rapid rusting. On the western, double-circuit section, however, which will be exposed to the moisture-laden air from the Pacific, it will be necessary to use a wire that will not rust and that will combine high strength with high conductivity. For that reason the ground wire there will consist of 7/16-inch, extra-high-strength Copperweld strand which is being furnished by the Copperweld Steel Company of Glassport, Pa.

Lightning charges which may strike the overhead ground wires will be carried by them to the towers and thence down these steel structures into the earth; and, in order to facilitate the dissipation of such charges in the earth, there are buried beneath the transmission lines a double row of counterpoise or



CONCRETING TOWER LEGS

Heavy galvanized steel angles, which form the base of each tower, are surrounded with reinforcing "cages" before they are placed in correct position and encased in concrete. By means of a steel template and a set of jacks (left), the four corner posts are set at the same elevation, after which the concrete is poured into an enveloping conical form. Water for the concrete is hauled to the various sites in tank trucks. Mixers (right) are mounted on caterpillar trucks and discharge into hand barrows.

ground wires. These are really rods, of ½-inch black copper, between which are set crossties, one at each tower. The insulators will be of the porcelain suspension type, 10 and 10½ inches in diameter. Eighty carloads of these, or 253,700 insulators, will be required for the entire line.

As rapidly as camps are established and access roads are built, work is started on the tower footings. This phase of the undertaking is now in progress throughout a considerable stretch of the line. Most of the material along the right of way is soft enough to dig without shooting; but where rock is encountered it is easily handled by light L-54 paving breakers of Ingersoll-Rand make which are ideal for working in confined spaces. The holes for the footings range from 7 to 10 feet in depth, and are belled out at the bottom so as to help anchor the concrete. Laying out these footings along the irregular course is not an easy task, as they must be so placed that they will present even surfaces to the towers that are to rise on top of them. This is assured by the use of a steel template that is leveled by means of blocking and screw jacks. Around each of the heavy, galvanized angles that constitute the legs of a tower is assembled a "cage" of reinforcing steel before it is firmly embedded in the concrete footing.

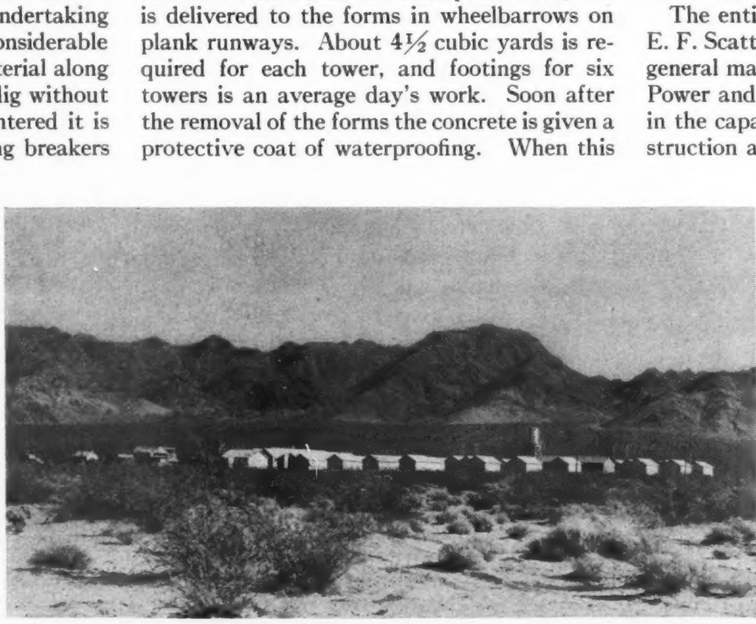
Sectional cylindrical forms that taper at the top are employed in pouring the concrete. The aggregates are obtained locally, in large part from dry stream beds, and the water is supplied by a large tank truck equipped with a pump and hose for wetting down the holes preparatory to casting the footings. The concrete is mixed in a ⅛-cubic-yard mixer that is mounted on a truck with Caterpillar treds, and is delivered to the forms in wheelbarrows on plank runways. About 4½ cubic yards is required for each tower, and footings for six towers is an average day's work. Soon after the removal of the forms the concrete is given a protective coat of waterproofing. When this is dry, backfilling is done by tractors and by hand labor.

It has been estimated that 55,000 cubic yards of material will have to be handled in excavating for the footings and that an aggregate of 28,000 tons of structural steel will be used in building the transmission towers. Their standardized members will be galvanized and assembled with bolts.

The entire project is under the direction of E. F. Scattergood, chief electrical engineer and general manager of the Los Angeles Bureau of Power and Light, with H. C. Gardett serving in the capacity of engineer of design and construction and R. R. Robertson as engineer of field construction.

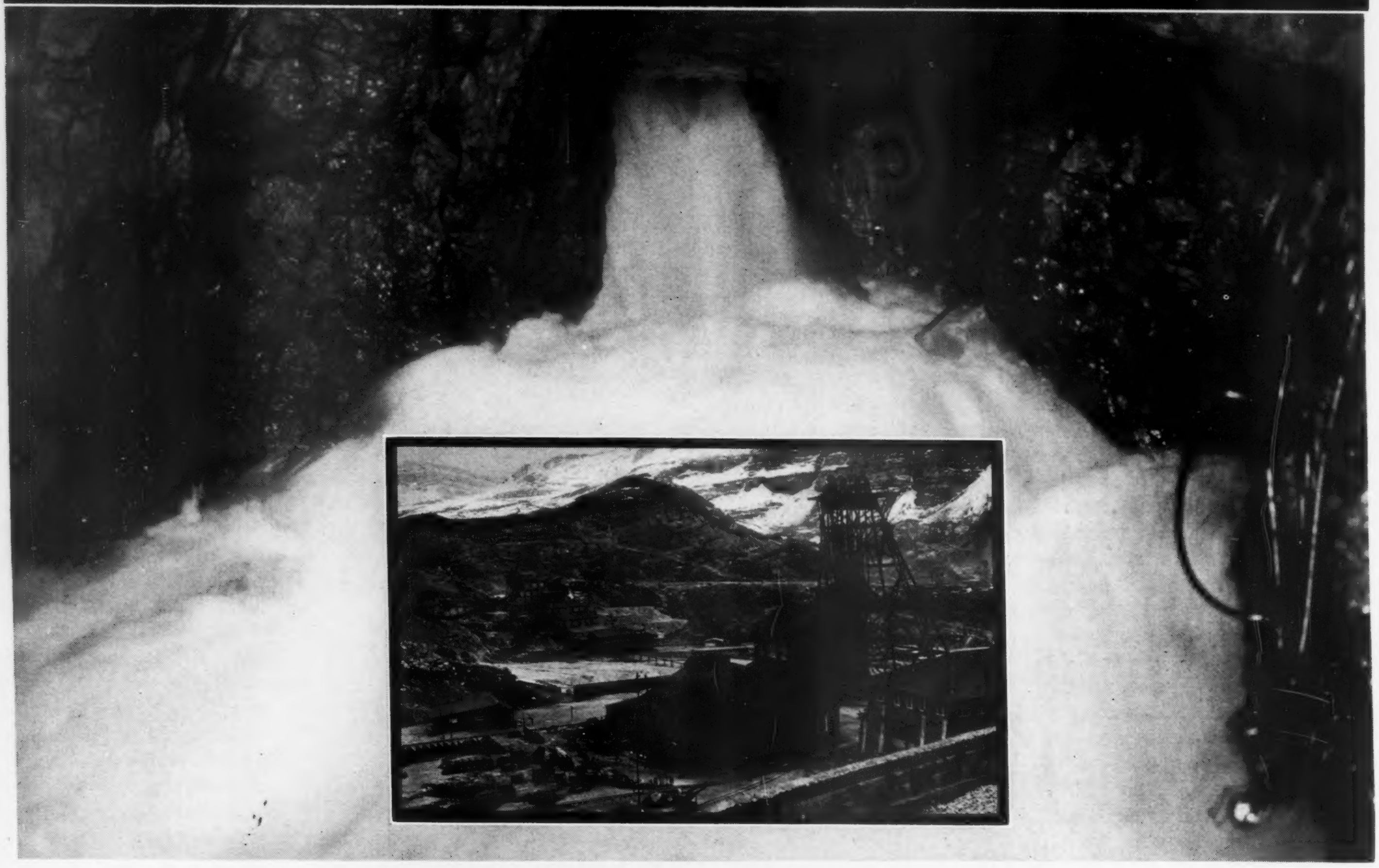
In speaking of this great project, Mr. Scattergood has said: "Boulder Dam will generate a peak load of 1,000,000 hp. Conservative students of local resources and history calculate that within a very few years the region within the economic power transmission distance of Boulder Dam will require 1,750,000 hp.

"Taking the present wealth of Southern California and the amount of electric energy now being utilized as a basis for comparison, it is estimated that both the wealth and the amount of industrial activity will be double what they were when the Boulder Dam contract was entered into."



TYPICAL CAMP

Jean Camp, near the Los Angeles-Salt Lake City Highway, is one of the seven settlements established between Boulder Dam and Cajon Pass. Water is supplied from deep wells. Comfort and welfare of the workers were of first consideration in outfitting these camps, which will be occupied for about two years.



A MAMMOTH UNDERGROUND CATARACT

LAST autumn, a torrential flow of water was encountered in the Mahr Tunnel of the Cerro de Pasco Copper Corporation, high in the Andes of South America. At its height, the outpouring from one source alone was estimated to be about 30,000 gpm., which would suffice to serve the normal needs of a city of 500,000 persons. The flood stopped all operations in the tunnel for some time, but gradually lessened to a volume where it could be handled without great difficulty.

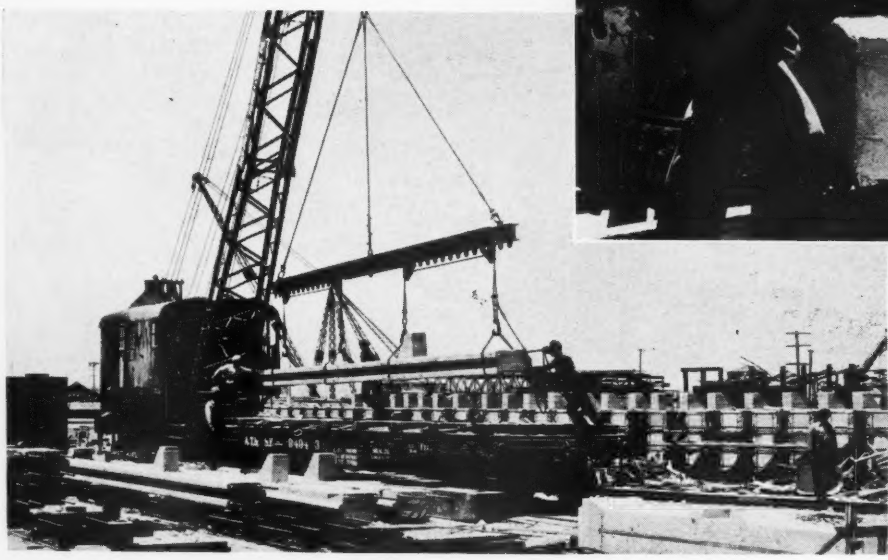
Two of the pictures show the outpouring. One of them was taken close to the point of its emergence from the rock and the other farther away towards the tunnel portal. A better idea of the volume of water involved can be gained if it is considered that the tunnel is 9 feet wide and 12 feet high. Marks on the tunnel walls indicate that the flow had already subsided appreciably when it was photographed.

This tunnel, which will be approximately six miles long, is being driven to drain the Morococha Mine. It will cut under the Central Shaft about 1,500 feet below the collar, and will materially reduce the problem of handling ground water. The shaft is now down 1,000 feet. One of the views shows the Morococha surface properties. The elevation at the top of the headframe is almost 15,000 feet above sea level.

This tunnel is being driven with Ingersoll-Rand S-70 drifter drills which are operated with air from two Class PRE-2 compressors. The heavy flow of water was struck at a point 23,183 feet in from the portal.

Fortifying Concrete Against Marine Attacks

R. G. SKERRETT



TREATING PENOCRETE PILES

Precast-concrete piles, up to 82 feet in length, are cured for 60 days and then picked up by special equipment (left) and placed in drying kilns. There they are heated for from eighteen to twenty hours before being impregnated with asphalt by the pressure-vacuum process. Above are shown piles being run into the asphalting chamber, which will be hermetically sealed by the massive door.

SHIPWORMS of various sorts levy annually a destructive toll that has a money equivalent of many millions of dollars. Recognized authorities have declared that the upkeep costs of numerous seaports could be greatly reduced if these marine creatures were exterminated or, failing that, if means were developed that would render immersed wooden structures immune to their attack.

Shipworms are not really worms, as the term is commonly understood, but mollusks that are veritable tunneling machines in miniature. In so brief a period as six months a horde of these pests will riddle a timber pile 2 feet in diameter and bring about its collapse! In their embryo stage they are swept to and fro by tidal currents, and several hundred of them may then attach themselves to a single square inch of a wooden structure anywhere between the low-water level and the mud line of the water bed. In that immature state they will enter a wooden body by the tiniest of openings, and from that moment onward will grow, advance, and progressively enlarge the passage made by them as they burrow—the forward edges of their shells cutting the timber like boring tools. When full grown, certain of these mollusks will range in length from a few inches to 4 feet.

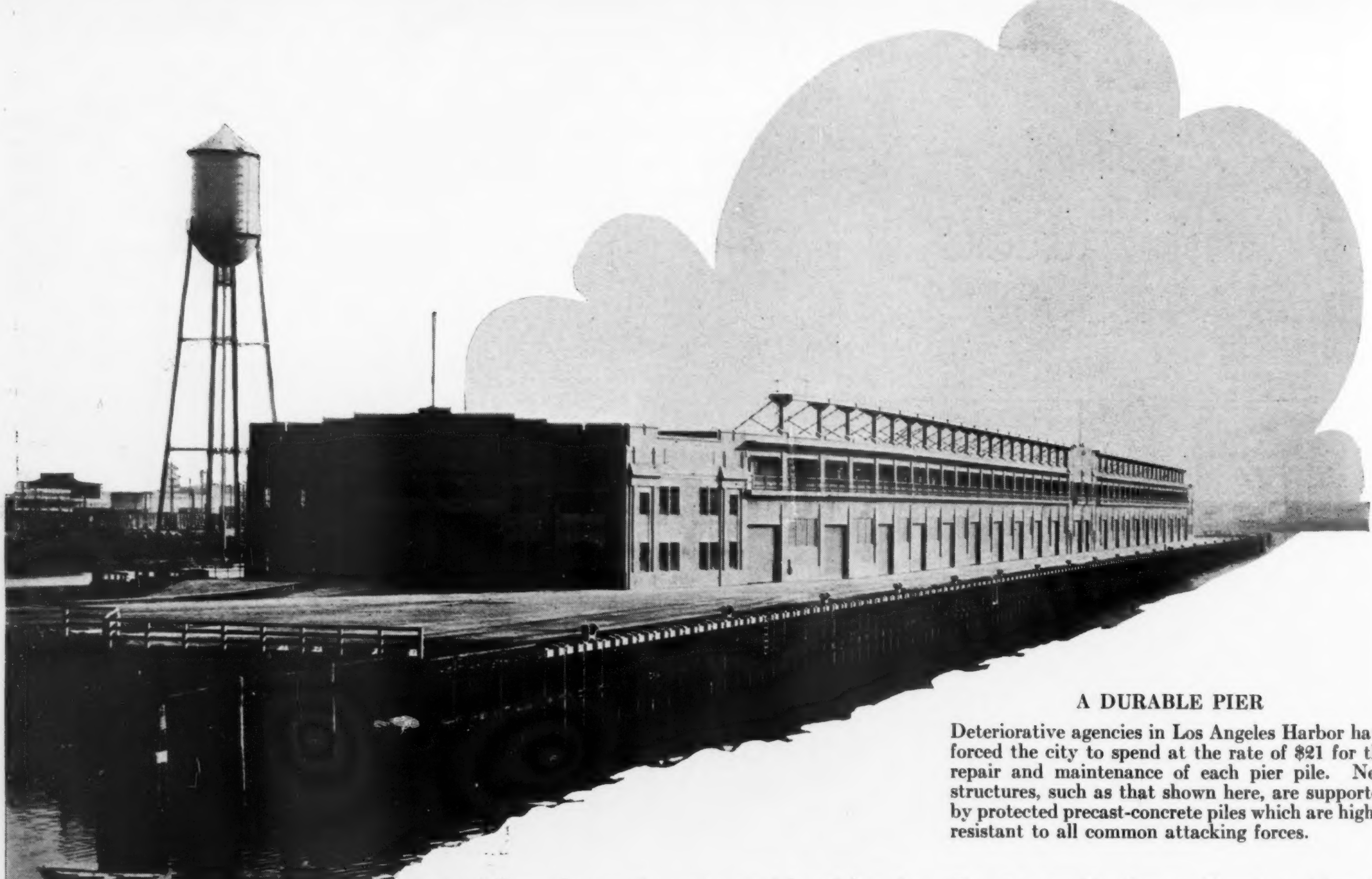
Wooden ships, spar buoys, rafter timber, wooden piling etc., have been attacked, damaged, and even ruined by these ravaging shellfish; and for decades there has been an unceasing effort on the part of engineers and inventors to devise ways and means by which these insidious forms of animal life could be rendered impotent. Probably no seaport in this country has waged a more persistent battle with these creatures of salt seas and tributary waters than has San Francisco.

Since the "eighties", the authorities of that Pacific port have struggled with two types of shipworms—technically termed *Limnoria* and *Xylotrya*; but at the end of each 10-year round the borers were ahead in the fight. To some extent their advantage in the combat was attributable to carelessness in the use of the protective measures devised by experts—creosoting being employed and the wooden piles, in numerous instances, being further shielded by a concrete envelope. In 1911, precast-concrete piles were used in the Port of San Francisco; but most of the wharves, piers, bulkheads, etc., were of wood and not safeguarded against the ravages of the two types of borers known there up to that date.

The climax came between 1917 and 1920, when the *Teredo navalis* suddenly appeared in San Francisco Bay and caused unparalleled havoc wherever wooden structures were exposed to those invading billions. According to published reports, the borers were responsible within that span for damages that called for replacements costing $20,000,000. No one was able to determine from what center of infection the *Teredo* reached the local waters, and there was no record of that species of shipworm having been there before. The port authorities and scientific and technical experts were mustered to study the life history of the pest and, if possible, to evolve protective measures.

It is not the present purpose to follow the subject further than to say that the surest safeguard against attack was the substitution of concrete for timber wherever timber could not surely be made resistant to the shipworm. It was realized that well-made and carefully driven precast-concrete piles, or properly formed concrete subaqueous structures, were the best defense against marine borers and, besides, that concrete was not inflammable and, therefore, not a fire hazard. The unexpected and destructive activities of the *Teredo* gave a new urge to the use of concrete in harbor works of a permanent nature; but it was recognized that timber, because of its resilience, was preferable for those parts of piers, etc., that have to receive the impact or rub of shipping. Now let us shift to another scene of action on our West Coast, to the Port of Los Angeles.

Profiting by what had happened elsewhere, the Port Authority of Los Angeles set about making the harbor of Wilmington and San Pedro truly representative of California's most populous city, and, as far as practicable, used concrete in building wharves, piers, bulkheads, retaining walls, and breakwaters—the concrete being usually reinforced with steel.



A DURABLE PIER

Deteriorative agencies in Los Angeles Harbor have forced the city to spend at the rate of $21 for the repair and maintenance of each pier pile. New structures, such as that shown here, are supported by protected precast-concrete piles which are highly resistant to all common attacking forces.

Although this form of construction is not attacked by borers, if we except a relatively few instances in which it has been penetrated by *Pholads*—a rock-boring type of mollusk that manages to drill into poor concrete, still another source of trouble developed that was traceable to various actions and reactions set up by salt water. This brought to light a new and ever-present problem.

Concrete piles and other marine structures of concrete are continually exposed to abrasion by floating bodies and to erosion by waves; and the area so exposed lies principally between the limits of high and low water. The sweep of winds and pronounced temperature changes likewise contribute in varying degrees to impairment and, perhaps ,to the destruction of the concrete, especially within the vertical range mentioned. The sea air, with its saline content, also attacks concrete floors and beams exposed to it. An outline of the situation will make it understandable.

Ordinary concrete is porous, and its porosity varies with different mixtures. It therefore follows that as the water used in mixing the concrete evaporates from the small pores so will the external water or moisture penetrate by way of the same passages. Therefore, when exposed to sea water and sea air, it is vulnerable to attack and suffers from the chemical actions thus induced. These actions are progressive; and disintegration and breakdown are accelerated wherever reinforced concrete is so affected because the steel, when reached, oxidizes, expands forcibly, and causes the concrete to spall. Where concrete is exposed to frost, the water absorbed by it expands in freezing and causes cracking and spalling. In addition to the cracks induced by temperature changes, other minute ones are developed in piles during their handling and driving. All these fractures offer ready paths for the penetration of moisture. Manifestly, then, sea water and sea air have created a new battle front for engineers engaged in designing and building marine structures.

Such being the situation, we may properly ask: What has the Los Angeles Harbor Department done to hold at bay what might be termed a perpetual menace to marine structures? Revolutionary work to this end was started in 1920; and details have been disclosed by G. F. Nicholson, harbor engineer. At that time a method was devised for impregnating precast piles with asphalt—the piles being immersed in an asphalt bath heated to a maximum temperature of 500°F. The piles remained in the fluid for from 15 to 24 hours. This procedure was resorted to only after experiments had proved that it was impracticable to coat concrete with a protecting film that would adhere uniformly and last for any reasonable service period. To insure the desired degree of penetration by the asphalt, the concrete was made of a porous and lean mix that did not, however, make a suitable bond with the reinforcing steel. Its inherent weakness was further increased by exposure to the high temperature of the bath. But that temperature served to vaporize and to release much of the free water in the concrete and, by inducing partial vacuums in its pores, caused the asphalt to flow inward. Although the first of these piles were not so strong as desired, still they pointed the way to the goal sought and successfully resisted the action of sea water and sea air for a decade.

The Fish Harbor Breakwater at Wilmington contains 2,200 asphalt-impregnated, precast-concrete sheet piles, the last of which were driven less than a year ago. These piles were manufactured by the Pan-Pacific Piling & Construction Company and impregnated with asphalt by a vacuum-pressure process that was developed to overcome the shortcomings of the earlier bath method just referred to. The improved procedure is, so far as impregnation is concerned, somewhat similar to that widely used in creosoting lumber. To make the most of the latest treatment, the piles, themselves are manufactured by a special process.

Penocrete piles, as they are called, have been worked into numerous West Coast structures that are exposed to sea water; and so far more than 770,000 linear feet of them has been placed. The oldest and earliest of them—now in service ten years—are still wearing well and showing their special fitness

for marine use. In the precast bearing pile, as distinguished from the sheet pile, the core is made of ordinary strength concrete and is protected, throughout a vertical distance extending from 3 feet below low water to the top of the pile, by a jacket of drier and more porous concrete. This forms an envelope 1½ inches thick. A compressive strength of 4,000 pounds per square inch is required for the core. The core and the shell are poured simultaneously—the vertical steel plates which serve to separate the two concretes during casting being progressively withdrawn. The concrete is compacted by vibrating the form with air-driven hammers and by ramming the material, itself, with pneumatic tampers while it is being poured. By employing two concretes it is practicable to obtain a general penetration of the asphalt to a depth varying from 1½ to 2 inches in the jacket section and from ¼ to ⅜ inch in the section not protected by the jacket. In this way, that part of a pile that most needs protection against abrasion, erosion, and disintegrating sea water and sea air is more or less safeguarded.

Following their casting, the piles undergo a curing period of 60 days. At the end of that time they are transferred by steel carriages, traveling on a perfectly level track, to a preheating chamber, in which they are held for from eighteen to twenty hours. During sixteen hours of this period the temperature is raised hourly at a rate of about 10°F. until a maximum not exceeding 250° is reached. This progressive increase in temperature serves to prevent the setting up of harmful stresses in the piles. After the piles have been preheated they are shifted quickly from the chamber to a treating cylinder—a strong steel structure 8 feet in diameter and long enough to receive piles up to 82 feet in length. The cylinder has circular swinging doors—one at each end—that can be sealed hermetically, and is preheated before the admission of a lot of piles.

As soon as the impregnating cylinder is sealed the vacuum pumps are started, and a vacuum of from 26 to 28 inches is induced. This promotes the further dehydration of the concrete and makes it more absorptive of the hot asphalt when it is admitted. Asphalt is fed into the cylinder until the piles or other forms of concrete are submerged in the bath—at which time the vacuum pumps are shut down and air pressure is applied to the free surface of the asphalt. This pressure, which may vary from 100 to 150 pounds per square inch, is maintained for from twelve to fourteen hours. During the first hour of the impregnating period the asphalt is held at a temperature approximating that of the maximum cited: after that there is an hourly drop until the thermometer indicates 100°F. Then, or at some subsequent point, while air pressure is still applied, the fluid asphalt is drained from the cylinder. When the piles have cooled down sufficiently they are run from the cylinder into a draft-free chamber where further cooling takes place gradually; and in this manner they are, for all practical purposes, annealed. These reinforced piles are manufactured in lengths of from 50 to 80-odd feet.

Inasmuch as compressed air and vacuum are utilized in the manufacture and the subsequent impregnation of the piles, a sizable plant is provided for these essential services. Compressed air is furnished by five machines: one low-pressure unit with a capacity of 210 cfm., and four high-pressure units that have a combined discharge of 500 cfm. There are also two vacuum pumps. Both the compressors and the vacuum pumps, as well as the pneumatic tools used in tamping and vibrating the concrete, are Ingersoll-Rand products.

There is ample warrant for the belief that the adoption of Penocrete piles will obviate the more or less periodic repair necessary in the case of reinforced-concrete piles not similarly safeguarded against deterioration promoted by sea water. Repairs of this sort in Los Angeles Harbor have cost the municipality an average of $21 a pile. Piles are not always readily accessible for rehabilitation, and the floor or deck of a pier may have to be opened to make the work possible—adding, accordingly, to the cost and, perhaps, interfering with routine and the profitable use of the marine structure. Experience has revealed that salt spray is likely to damage the underside of the concrete deck of a pier. This has led to another development in the art of impregnating concrete structures with asphalt—we refer to what are known as Penocrete slabs, which are produced under the patents of J. W. B. Blackman, president of the Pan-Pacific Piling & Construction Company.

These slabs can be utilized to form either a lining or a covering for concrete sewers, sea walls, bridge piers, aqueducts, wharves, pier decks, etc., so as to protect them from the damaging attack of salt water, sewer gases,

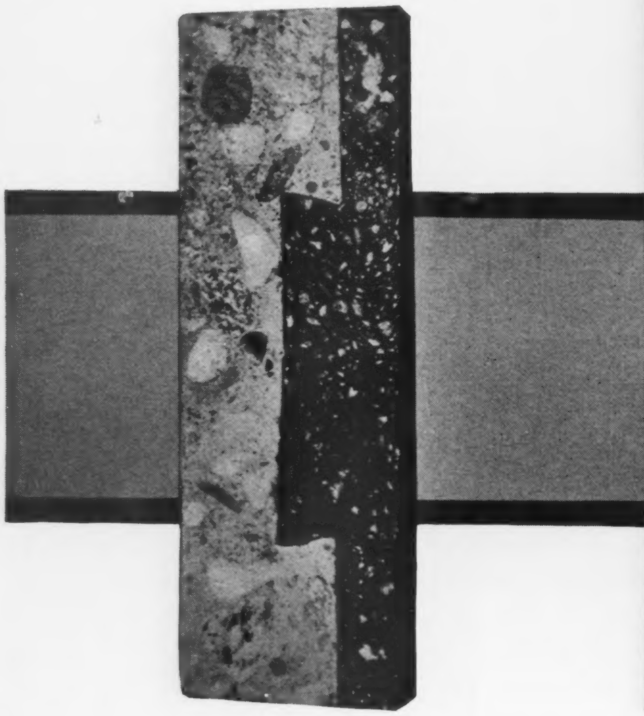
PROTECTING EXPOSED SURFACES

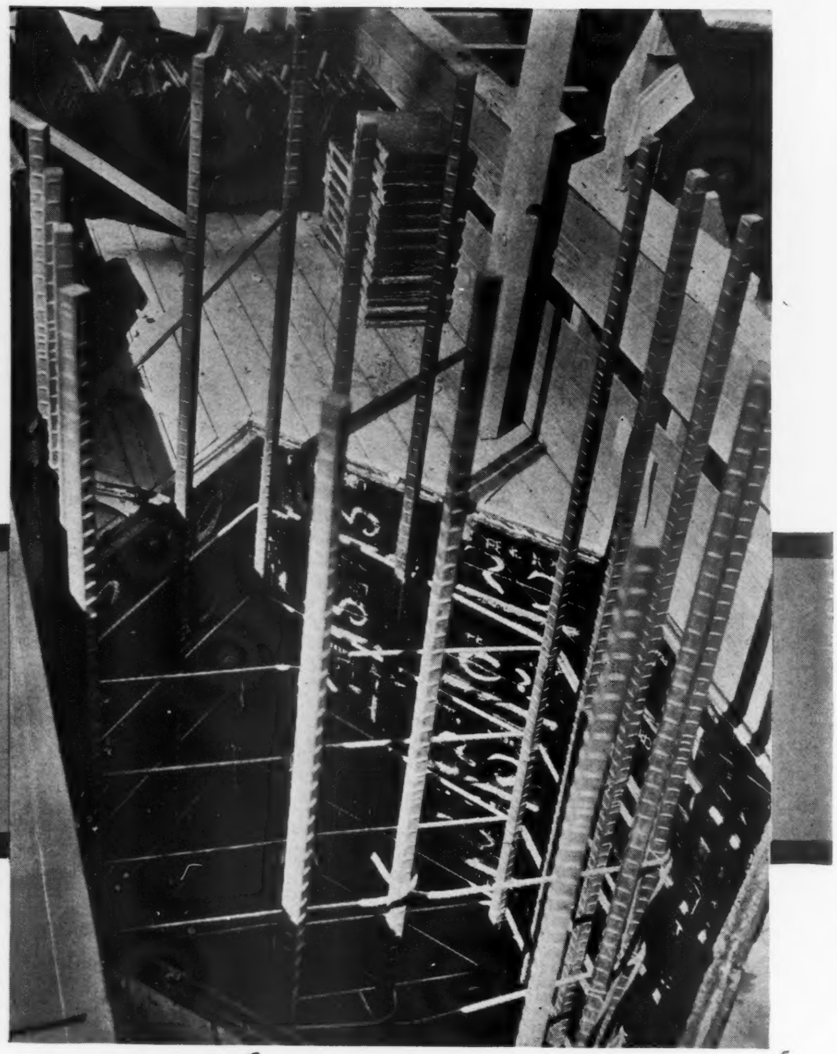
All surfaces of the outlet tunnels of the Seal Beach plant of the Los Angeles Gas & Electric Corporation that are exposed to salt water are faced with concrete slabs (right) impregnated with asphalt.

Below is Fish Harbor Breakwater in Los Angeles Harbor. Completed a year ago, it contains 2,200 asphalt-impregnated, precast-concrete sheet piles. These supports are 17x24 inches in section, and vary in length according to the depth of the water where they are placed.

APPLYING PROTECTIVE SHEATHING

Some piles are fabricated with an exterior wall made up of impregnated slabs. At the right is a form for a reinforced-steel pile. The treated members will constitute an integral part of the poured product. Below is a section of such a pile showing how the impregnated slabs are bonded to the central core of ordinary concrete by means of keyways.





and acids, or from abrasion and erosion due to one cause or another. The slabs can be fashioned in any shape and dimensions to meet requirements and, in practice, are assembled against timber studding. They may even constitute a form within which concrete can be poured—the slabs becoming an integral part of the freshly cast concrete.

One recent application of these asphalt-impregnated slabs will suffice to make their use clear. They were employed to provide protecting linings against the action of salt water in the discharge tunnels of the steam-generating plant at Seal Beach of the Los Angeles Gas & Electric Corporation. Each slab was about 1 foot wide and 3 feet long, with a maximum thickness of 2 inches. One top edge and one side edge were grooved, while the other two edges were tongued—the joints with contacting slabs being completed by means of hot asphalt that softened the contiguous surfaces and thus caused them to unite and to make them watertight. A rectangular, depressed central area at the back of each slab, where the concrete was about 1 inch thick, acted as a keyway for anchoring the poured concrete. The slabs weighed about 50 pounds each, and one man could readily handle them and fit them together.

Penocrete slabs are made of a strong but comparatively porous concrete so as to facilitate impregnation, and the relatively dry mix is tamped pneumatically into the forms. After a curing period, they are dried in a chamber in which the temperature is progressively raised to a maximum of 225°F. At the proper time, the slabs are transferred to the treating cylinder and there impregnated by the vacuum-pressure process. Slabs of this kind, when assembled and bonded in the manner described, have been tested under a hydraulic pressure of 50 pounds per square inch and have been found tight. Where holes were discovered in joints in the aforementioned tunnel linings, they were easily and effectually sealed by brief exposure to a blow torch that softened and united the asphalt. Anyone familiar with concrete structures will readily grasp how such slabs can be applied to give them much desired protection.

A short while back, a 50-foot precast concrete pile was encased within Penocrete slabs and driven to refusal to a depth of 48 feet with a No. 2 Vulcan steam hammer. Upon withdrawal, the pile was critically examined and found to be in perfect condition—the driving in no way having damaged the slabs attached to it. It is conceivable that it would be a distinct advantage in some circumstances to give asphalt-impregnated piles added protection in this manner and thus to increase their defensive area. Tests made to ascertain the effectiveness of the bond between the slabs and the concrete have shown an average resistance to fracture of 8,185 pounds.

There is reason to believe that Penocrete piles of the regular form can be counted upon to give a service life of 75 years—that is, they are likely to outlast by a long time the structures set upon them. It is therefore understandable why the harbor authorities of the Port of Los Angeles have adopted concrete piles, impregnated with asphalt, for permanent harbor works. The gain in durability and the added security contribute to economy and to operating efficiency.

Much has been written by engineers, chemists, and other recognized authorities on the damaging actions of sea water and certain alkalies upon concrete, showing how widespread and seriously the subject has been considered. Asphalt-impregnated concrete piles and slabs provide a means of combating the harmful effects of sea water, salt spray, etc. and in that service should find an extensive field of application. In the making of these new products it is interesting to note how vacuum and air pressure are used to help build up the desired measure of defense. Once more we see how technical resourcefulness, inventiveness, and readily obtainable mechanical agencies have been brought together in consolidating the battle line against age-old forces

SAMPLES OF PAVEMENT

The eye cannot peer into concrete, of course, but the "Calyx" core drill brings sections of it right out into the open for measurement and inspection. These cores have been extracted, checked for thickness, and examined for the quality of the mix and the position of the reinforcing members. Numbers have been painted on them for identification at a later time if this should become necessary or desirable.

Cores of Concrete Information

ALLEN S. PARK

THERE are approximately 24,000,000 automobiles in the United States, or, roughly, one for every five persons. Probably 75 per cent of these vehicles are used a portion of every day. Assuming that each car averages fifteen miles daily, which seems conservative, our national motor cavalcade amasses the staggering annual total of 130,000,000,000 miles. This is equivalent to more than 2,500 round trips from the earth to the moon. In view of these facts it is not surprising that we have emphasized roadbuilding to the point where our network of highways is the finest and most extensive to be found in any similar area on the earth.

Many of our arterial highways are surfaced with concrete; and, as a result of their vast experience, engineers and contractors have become highly skilled in the construction of this type of pavement. Occasionally we see concrete roads that have gone to pieces under the pounding of heavy traffic or because of the settlement of the earth subgrade on which they rest. For the most part, however, those sections were put down before present-day roadbuilding standards were adopted and, accordingly, cannot fairly be said to typify the best in concrete highway construction today.

Sporadic protests against the gasoline tax from which these roads are largely financed are to be expected in times such as these. That they are not more numerous, and that there is almost a total absence of criticism of highway development, can be ascribed, in part at least, to the fact that good roads advance the welfare and happiness of a large share of the people. American motorists realize that those who dance must pay the piper; but because they can step into their cars and go almost anywhere quickly and comfortably under practically all weather conditions they count themselves fully compensated for the money they thus expend.

The general satisfaction of the public with what it gets for each dollar spent in roadmaking reflects the efficiency with which roads are now built. Specifications have grown more and more rigid, and in nearly every state they are strictly enforced through competent and adequate supervision and inspection. In cases where the Federal Government assists in the financing there is double control of all the essential operations. The day of the irresponsible contractor has passed. Highway departments possess and assert the right to award contracts only to those that have demonstrated their fitness for building roads. Surety companies will no longer gamble with "shoestring" operators. A bidder on a public-road job must present evidence of his financial stability in order to secure a bond; and without such a bond his bid is automatically rejected.

Roadbuilding, then, has been put on a business basis; and the same precautions are taken to insure an adequate return for the money spent as are commonly exercised by large and well-run private concerns. Every stage of the construction is closely scrutinized and checked. Furthermore, in nearly two-thirds of the states, the concrete is actually sampled after it has been laid to make doubly sure that its thickness, composition, and workmanship measure up to specified standards.

The technique of this sampling procedure has been developed to such a high degree that it can be done quickly and inexpensively. By means of special equipment, cores are taken from the pavement for inspection and testing much as a vendor of watermelons plugs his fruit to convince the prospective purchaser that he is being offered a desirable specimen. Concrete cores are generally taken to check thickness, but, on occasions, they also serve for tests of strength. In addition, they afford a means of virtually looking into the pavement. It requires but a few seconds of examination of a core to learn whether the reinforcing members have been properly placed, whether the concrete has been adequately mixed and consolidated, and whether it is free from earth, bits of wood, and other undesirable materials.

The coring of pavements has been practiced in some states for nearly fifteen years. States that do not provide for it in their specifications are usually those that construct comparatively little concrete highway. In practically all instances it is stipulated that the final payment shall not be made to a contractor until his work has passed this test. When the custom was

first started there was, perhaps, a feeling on the part of some contractors that they were being spied upon and that the engineers were going out of their way in an effort to detect shortcomings. Reputable contractors have long since come to recognize, however, that coring acts in their favor. They know that an unethical competitor cannot underbid them with the expectation of saving money by skimping on the thickness of the concrete. They are, accordingly, protected from cut-throat bidding.

From the public standpoint, coring fully justifies the expense involved. On an average, reinforced-concrete paving costs around $20,000 a mile, exclusive of the subgrade. Only a fraction of 1 per cent of this sum is required to take enough samples to prove positively that it is or is not of the designated thickness. In the average state, the discovery of the fact that the concrete in a single mile of pavement is deficient in thickness will effect a saving more than sufficient to meet the cost of taking cores for an entire year.

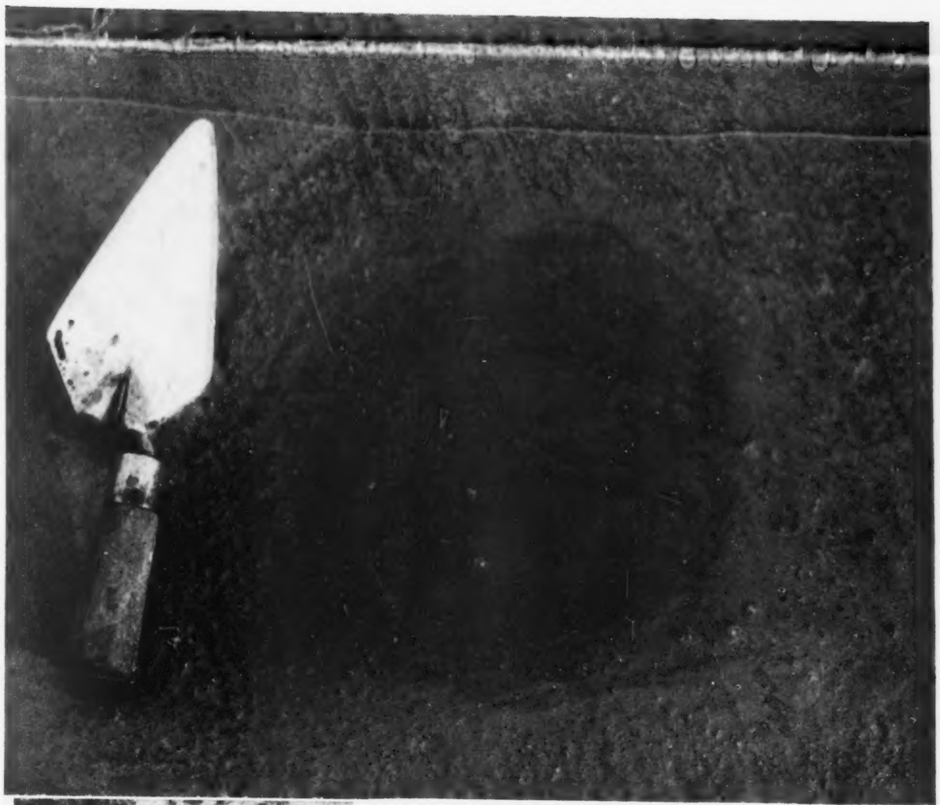
Pennsylvania was one of the pioneers in this form of testing highways, having inaugurated it in 1919. During the intervening years the procedure has been developed to a point of high efficiency. The work is carried on for the Department of Highways by the office of the Engineer of Tests and Materials Investigation, and is only one phase of various routine field and laboratory investigations conducted by that office to make certain that contractors adhere to the specifications under which they operate. Through a combination of thorough organization, efficient and intelligent personnel, and economical equipment, supplemented by a broad experience, the core-drilling department has become a smooth-working agency which operates at a cost of only $3 a core. This sum represents the over-all expense, including time spent by the crews at other work. If coring operations, alone, are considered, the actual cost per core taken ranges around $1.30.

The equipment used in Pennsylvania, as well as in other states, for extracting cores is a form of drill known as the "Calyx" core drill. It derives its name from the fact that it uses "calyxite", or chilled shot, as its cutting medium. In larger sizes, such drills are used throughout the world for testing foundation footings, for putting down large-diameter holes, and for other purposes. It is possible to obtain machines of this type that will drill holes 36 inches in diameter and extract a core showing the exact nature of the material penetrated.

CORE DRILL AT WORK

A general view and a close-up of one of the Pennsylvania Department of Highway's three outfits in action. The operator applies pressure to the bit, as desired, by merely turning the hand wheel. The upper picture shows the guide board in place to keep the abrasive within the drilling zone while the hole is being started. Water is fed to the interior of the bit through the small pipe that enters it at the right.

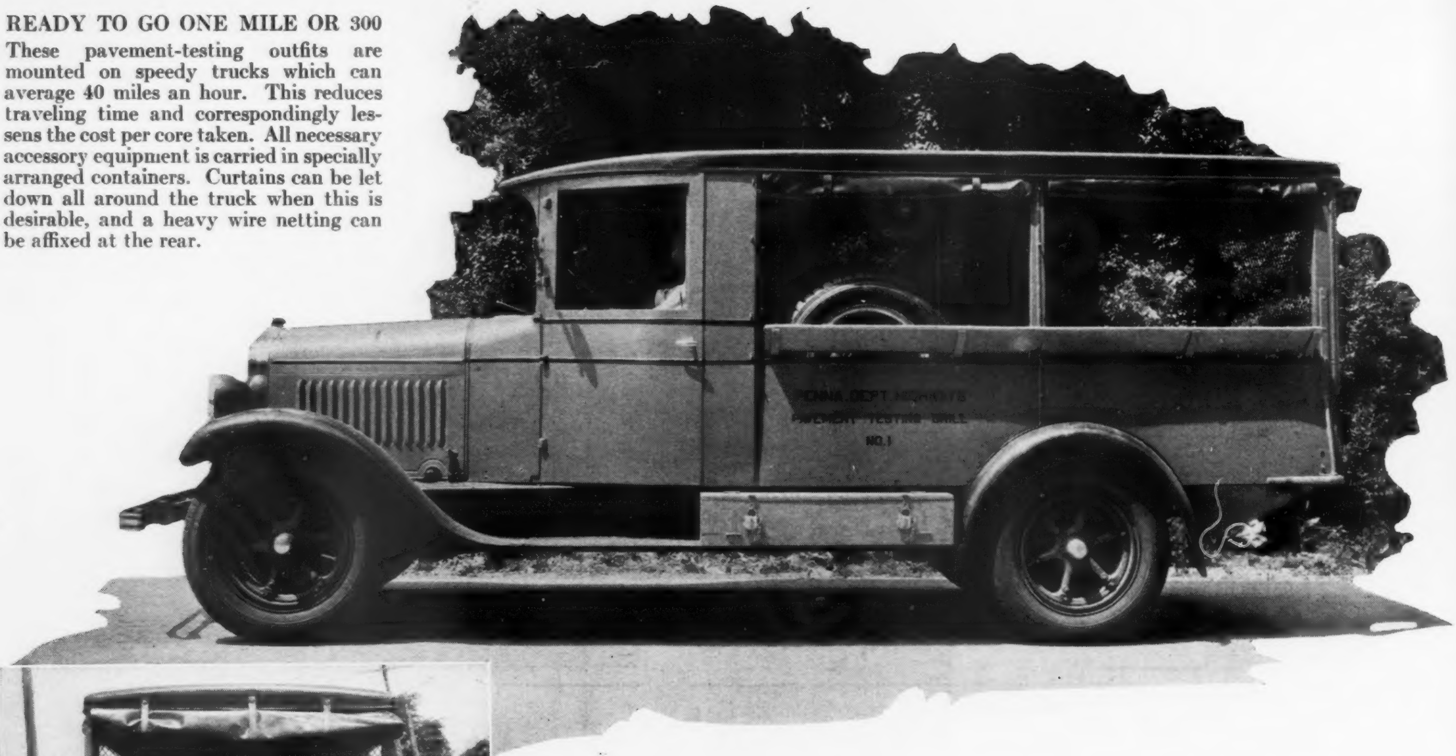
For the work under discussion, Ingersoll-Rand Company, manufacturers of this equipment, has developed a special small-size pavement-testing drill known as the Class PT. A general idea of the manner in which it operates can be gained from the accompanying illustrations. It is designed for mounting on the rear end of a truck bed, and is so set up wherever it is in use. Power from a 10-hp., 2-cylinder gasoline engine is transmitted through gears to a vertical shaft, on the lower end of which is mounted a cylindrical hollow-steel section which constitutes the cutting bit. At one point on the circumference of the bit is a narrow slot, inclined at an angle, which extends upward from the bottom edge. As the cylinder revolves, the shot is carried around the circular channel by this groove and gradually worked under the cutting edge of the bit. There it is broken up into angular fragments which constitute an effective grinding agency. To hold the shot in place when starting a core, a guide board is used. As illustrated, this consists of a short section of plank through which is cut a circular hole slightly larger than the outside circumference of the cutting bit. This guide board is laid on the pavement and the bit is inserted through the hole, the edges of which form a shallow inclosure which keeps the shot from escaping. Water is fed in a constant small stream to cool the bit and to assist in the cutting operation. The amount of wa-



THE CORE EXTRACTED AND THE HOLE REFILLED

The larger view shows the extracted core, the bit, and the guide board. The slot in the bit, which keeps the shot moving around the circular cut and works it under the grinding edge, is plainly visible. The smaller picture shows, at the right of the trowel, the area of the drilled pavement as it appeared after being refilled with dry-mix concrete.

READY TO GO ONE MILE OR 300
These pavement-testing outfits are mounted on speedy trucks which can average 40 miles an hour. This reduces traveling time and correspondingly lessens the cost per core taken. All necessary accessory equipment is carried in specially arranged containers. Curtains can be let down all around the truck when this is desirable, and a heavy wire netting can be affixed at the rear.



ter required varies with the character of the material being cored. The drill and its supporting carriage can be lowered, as desired, by merely turning a conveniently placed hand wheel which, through the action of pinions and gears working on two vertical racks, serves to push the entire mechanism downward. By means of the same mechanism the bit can be rapidly elevated after the core has been cut. The drill assembly is mounted on structural-steel ship channels, making for a compact and light-weight unit that can be readily bolted to the bed of a truck.

The Pennsylvania Department of Highways purchased its first "Calyx" drill in 1919, and has been using this type of machine ever since. The first model was comparatively crude, as compared with the modern type; and the experience of the department with it led to recommendations for its improvement that assisted the manufacturers in developing the present highly efficient unit. After having used this first model and an intermediate one, the department bought three modern units in 1929. These were mounted upon White 1½-ton trucks, and constitute the equipment now in service. Those in charge of the core-taking work explain that the character of the motor equipment is one of the reasons for the low cost per core which has been achieved. These trucks can travel at more than 40 miles an hour; and although Pennsylvania is a large state, it is possible with them to reach any part of it from Harrisburg, the capital, in one day of travel. On numerous occasions the journey from that city to Erie, a distance of some 300 miles, has been made between morning and night. Each of these trucks averages approximately 10,000 miles annually, and the speed with which they can move from job to job enables many more cores to be taken each month than would be possible with slower-moving vehicles.

The core-taking procedure has been highly systematized and, as a result, all the essential steps are carried out with a minimum of delay. The highway specifications provide that no newly laid pavement shall be accepted by the state until it has been core-drilled and its thickness found to be as specified. The state is divided into twelve highway districts with six division engineers in charge of two districts each. It is the duty of each division engineer to notify the engineer of tests whenever a paving contract has been completed. This is done on a form which contains essential information such as the location of the work, the extent of the contract, the identity of the contractor, and the date when the last concrete was placed. At least two weeks are allowed for the curing of the concrete; and it is the aim of the department to take cores as soon as possible after the expiration of this interval so that the final payment to the contractor may be made without undue delay, and also to hasten opening of the section to traffic.

The office of the engineer of tests is in daily touch with the movements of the three core-drilling crews. After referring to the schedule of work, it fixes a day and hour for the drilling of the pavement just reported upon by the division engineer, and assigns the work to the particular drilling crew which will be in that section of the state at that time. The division engineer is accordingly notified, on a form provided for the purpose, that the drilling outfit selected will be at the designated place at a certain hour and on a certain date. The form also carries instructions to the division engineer to have on hand at least two laborers and the necessary materials and equipment for excavating and replacing earth shoulders, for edge measurement, and for refilling with concrete the holes left after the taking of the cores. These laborers are provided by the highway forces of the county concerned. This arrangement relieves the core-drilling crew of operations other than their particular work and enables it to cover the section in the fastest possible time.

When the office in Harrisburg notifies the division engineer, it also forwards instructions to the drilling crew that is to be at the designated location at the appointed time. Under this system the central office is able to route the three drilling crews in such a way that all jobs will be handled expeditiously and with a minimum of travel.

Each drilling crew consists of two men, a graduate engineer in charge, and a drill operator. They are carefully selected, as it has been found that the type of personnel has an important bearing upon the efficiency and economy with which the work can be conducted. The operator is a man who knows his equipment thoroughly and who can get the most out of it. In addition to his mechanical capacity he is so qualified mentally that, in case of controversy, his word will carry weight in court. Upon reaching the designated job, the drill is put into operation quickly. Training has

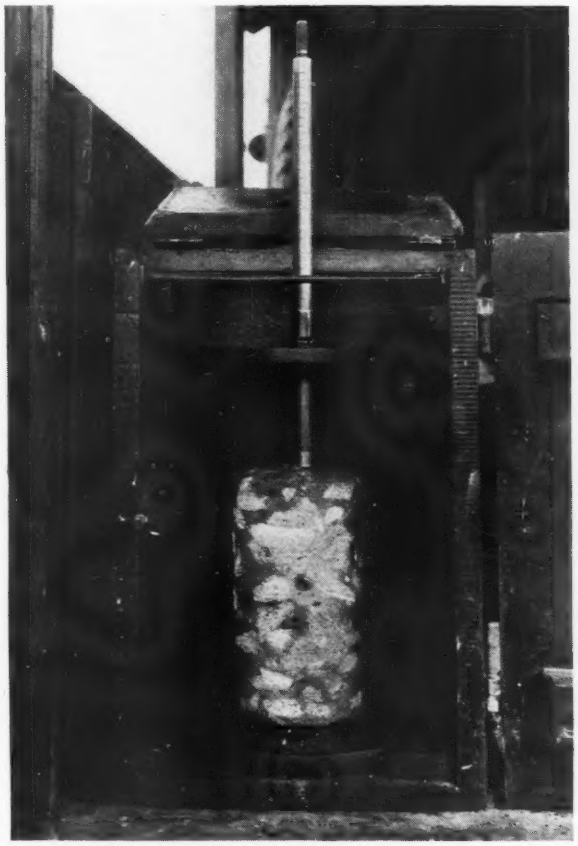
taught the operator where to drill, and he speedily maneuvers the truck into position.

The trucks are outfitted with all the required equipment, and this is arranged to facilitate the work. Extensions from the clutch, throttle, and spark controls have been provided to eliminate the necessity of getting into the truck to operate them. Ample supplies of shot are carried, and a 60-gallon tank provides sufficient water under average conditions for the taking of 25 cores. A hand-operated pump on each truck makes it possible to refill the tank from any roadside source in a few minutes.

Although shot, alone, is ordinarily used with "Calyx" drills, the Pennsylvania forces prefer a mixture of shot and grit, particularly for starting drilling. This grit consists of shot fragments and is usually mixed with an equal amount of "calyxite". Although the quantity of abrasive needed varies widely, an average of 50 cores is secured for every 100 pounds, and as many as 100 cores have been taken under favorable conditions. Continued practice has reduced the time required for taking cores; and in 7-inch concrete the operation can be completed in from 8 to 13½ minutes. The speed of cutting depends upon the composition and the thickness of the pavement. As many as 59 cores have been taken in eight hours from concrete made with limestone aggregates. The most resistant concrete is that made with aggregates of traprock. Cores for checking thickness are 4½ inches in diameter. Where it is desired to secure samples for compression tests, which is infrequent, 6½-inch cores are extracted.

Practically all concrete pavements are now laid in the form of two adjoining strips corresponding to two traffic lanes. The specifications provide that one core shall be taken from every 1,000 linear feet of pavement in each lane unless otherwise directed by the engineer in charge. The cores are staggered alternately on the two sides of the center line, and are taken at points measuring an even number of feet from the outside edges. Often the thickness of the concrete in each strip varies by specification—as, for instance, 9 inches in the center and 7 inches at the outer edges, with a graduating thickness between these two limits. In such cases, reference to a table of ordinates enables the drilling crew instantly to check the specified thickness at the point drilled. When the core has been extracted, it is placed in a measurement gauge which is graduated to twentieths of an inch and is there checked against the prescribed thickness. A number is then painted upon the core to identify it later should this become desirable. At the time each core is taken, there is removed enough dirt to expose the edge of the pavement directly opposite. This is also measured and checked against the specified thickness. Data regarding each core are entered upon a special form, and at the end of the day a complete record of the work done is mailed to the office in Harrisburg. From these field reports certification is made as to the acceptability of the highway concerned.

If the core taken shows the concrete to be not more than ¼ inch deficient in thickness, the pavement in that 1,000-foot section is considered to be satisfactory so far as its depth is concerned. If a core measures more than ¼ inch but not more than ½ inch less than the specified thickness, a second core is taken in the same section and within 50 feet of the point where the first was extracted. If this also is deficient, the contractor is paid for that section at a proportionately reduced price. If the pavement proves to be more than ½ inch less than the specified thickness, then the contractor concerned is requested to remove it and to replace it with new concrete. In justice to the contracting fraternity, it should be recorded that it rarely becomes necessary to enforce this last-named provision of the specifications.



MEASURING THE CORE

The concrete cylinder is placed in a measuring box, carried on the rear of the truck, and its height checked to five-hundredths of an inch. The gauge is an inverted one, enabling the measurement to be taken direct.

Under the system followed in Pennsylvania, all highway equipment used is in charge of an equipment division, which rents it out to the various departments at stipulated charges. The core-drilling outfits come under this category, and are maintained, serviced, and fueled by the equipment division. The rental paid for each unit, complete with truck, amounts to about eighteen cents per mile traveled. Drilling crews are capable of making emergency repairs in the field; but, ordinarily, are able to have such work done at one of the more than 50 shops maintained in various parts of the state by the equipment division.

Because traffic increases greatly, no core drilling is done on week-ends. Ordinarily, new concrete sections are core-drilled before they are opened to public use; but, even where the roads are already in service, the drilling operations are carried on so speedily that traffic is interfered with only a short time. While an outfit is at work it occupies only one lane, so that there still remains room for 1-way traffic. Caution signs are stationed a few hundred feet away on both sides of the location to warn approaching motorists. These signs are placed and removed by the assisting crew provided by the county concerned to perform the labor incidental to core-taking. Such a crew normally consists of two men in a truck equipped with necessary materials and tools. As soon as a core has been extracted, these men prepare sufficient dry-mix concrete to fill the hole. Formerly, precast-concrete cores were inserted in the openings and cemented into place, but it was found that freshly mixed concrete was more satisfactory. The concrete is tamped by hand and leveled off with a trowel. After the highway has been in service a few weeks, it is difficult or impossible to identify a spot from which a core has been taken. The assisting crew also removes the dirt from the side of the concrete slab to permit taking the edge measurements, and later replaces it.

The number of cores taken annually varies, of course, with the amount of new concrete highway placed. The record year to date was 1930, when 9,297 cores were extracted from 818.6 miles of road. The number of cores removed in other recent years was as follows: 2,315 in 1929; 3,004 in 1931; and 2,912 in 1932. The foregoing figures take into account only the cores extracted for the purpose of checking the thickness of the concrete. Other cores were taken from time to time for special purposes.

Aside from their value in the work we have discussed, the core drills have proved helpful in other ways. Recently, the state-highway forces were made responsible for the paving of municipal streets which are a part of principal through roads. In studying existing pavements with a view to determining whether or not they are adequate, or whether or not they are sufficiently stable to serve as bases for concrete or some other form of surfacing, the core drill quickly makes available a miniature section which gives the desired information. Many times such drilling has revealed unexpected facts. Oftentimes local records as to the thickness of an existing pavement are proved to be erroneous, and checking by core drilling has undoubtedly saved a good many thousands of dollars by preventing the surfacing of foundations not strong enough to support heavy traffic.

Sintering Conserves Our Iron Ores

EDWARD J. TOURNIER

TYPICAL SINTERING PLANT

Here is reclaimed the iron contained in blast-furnace flue dust. Raw materials are conveyed up the incline to storage bins, to be used as needed. The sintering machine is in the building at the right from which extend two chutes for loading the product into railroad cars.

GETTING something for nothing has been denounced as stupid and acclaimed as smart, depending upon the commentator's state of mind; but making nothing worth something is less subject to criticism. The relationship between this statement and the heading of these lines lies in the fact that it is by reclaiming waste products that iron-ore conservation can be made effective.

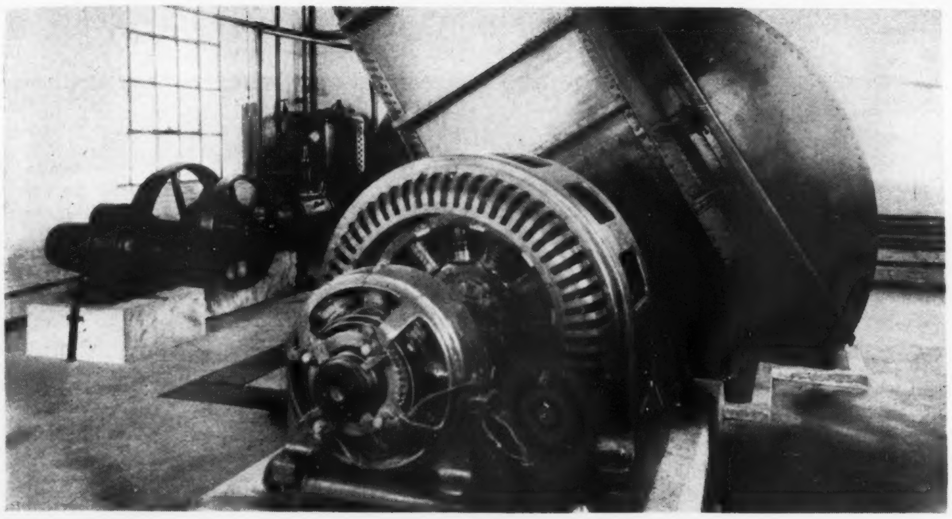
The report of the U. S. Geological Survey for 1930 states that the available supply of high-grade iron ore in this country does not exceed 7,500,000,000 long tons which, at the 1926 rate of consumption, will be exhausted in 125 years. This leaves out of consideration possible discoveries of new deposits and the utilization of material that is now thrown aside as worthless.

In the ore regions of Lake Superior and of Alabama, West Virginia, and several other southern states, there are vast quantities of iron ores which are unmerchantable either because of their powdery nature or because of their water content. Elimination of water would render these ores as good as those now being shipped, while another class, known as "paint rock", could also be used. The latter is found in working mines where "shipping" ore bears the burden of development and where paint rock could be mined without that initial cost. In addition there is blast-furnace flue dust in stock piles, which increases the total of reclaimable waste products.

The summation of potential blast-furnace

SINTERING MACHINE AND ITS PRODUCT

The central picture shows a sintering machine from the loading end. Material is fed to it from an overhead hopper and is conveyed by moving grates toward the discharge at the far end of the room. The charge of ore and fuel is ignited by gas, and thereafter supports combustion as it travels. At the left is a pallet with cellular iron as it looks at the discharge end of the machine.



INTERIOR OF FAN ROOM

This room is as large as an average dwelling. The 600-hp., adjustable-speed motor drives a fan which supplies suction air for withdrawing gases from the sintering machine through the inclined duct. At the left is an Ingersoll-Rand single-stage compressor that handles the gas used in igniting the sintering charge.

material is unofficially estimated at 10,000,000,000 tons. This, added to current supplies, makes an imposing total. The task of conservation is to transform this potential into actual value: to make of value something that is now worth nothing. The means by which to accomplish this are found in the process of sintering, which is already well established and needs only to be extended. It is today the only positive and practical method by which the life of our iron ore reserves can be greatly prolonged.

Sintering is essentially a roasting process by which iron-bearing ores in powdery form or of high moisture content are agglomerated into a mass of pure iron, cellular in structure and in form exactly suited to blast-furnace use. The product is obtained through fusion of the ore particles under a powerful down-draft of air while carbon and other extraneous matter are being burned out. In the latter operation, a charge of ore and fuel is ignited and then maintained in a burning condition for 10 to 30 minutes by a current of air induced by a suction fan. The central element of the process is a sintering machine, which carries the charge of ore slowly under an intense gas flame during the period of roasting. The finished product is known as "sinter".

The principal parts of a sintering plant comprise machinery for handling raw materials, a sintering machine, an ignition system, and air-circulating equipment. The sintering machine, air-circulating equipment, and the ignition system are grouped together in one building, while the materials-handling and storage facilities are housed separately to suit local conditions.

In order to follow easily the sequence of operations, a typical plant using flue dust will be taken as an illustration. Raw material, received in hopper cars, is discharged at a point near the sintering building and delivered to storage bins containing a 24 hours' supply. Mechanical feeders measure and discharge the flue dust on to a belt conveyor, which is partly level and partly inclined in order to carry its powdery load to the top of the sintering building.

On the uppermost floor of this structure there are two service tanks which receive the sintering material and fuel, or raw material and "diluent". This consists of small-sized sinter which is kept on hand and is mixed with the flue dust to reduce excess carbon. If the raw material is one of the other ores previously mentioned, then coke must be added to ignite the charge because the material is deficient in carbon.

Flue dust and diluent are drawn from the service tanks and proportioned mechanically before being mixed with water in a paddle type mixer. This is one of the most important operations in the process, because upon it depends the quality of the product, the efficiency of ignition, and the economy of power. The mix passes through a spout, which distributes the charge evenly across the width of the sintering grates on the machine.

This machine is visualized as a large conveyor-type traveling-grate stoker, of which the principal parts are "pallets", sprocket terminals, power-transmission units, wind boxes, and a supporting frame. The pallets are 4-wheeled, cast-iron carriages provided with grates, and they move along the top of the supporting frame. All the pallets forming the continuous line of grates are pushed from the loading end of the machine and carried along through the engagement of the drive sprocket with the first pallet in the line. The speed of travel varies from 30 inches to 90 inches per minute, depending upon the condition and depth of the charge and also upon the air pressure. This slow speed is obtained by a combination of spur gears on the machine and a speed reducer and belt drive, which produces a total ratio of 2,500 to 1 between the variable-speed motor and the drive shaft.

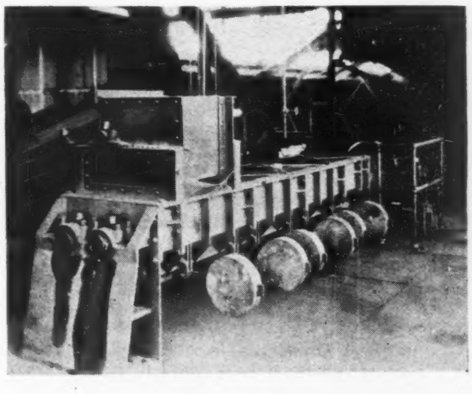
Sintering machines have been standardized in a number of sizes: in widths from 42 inches to 72 inches, and in lengths from 26 feet to 76 feet—the capacities for 24 hours ranging from 150 to 1,500 tons. Although some of them are of great size and weight, power consumption is low because of the use of roller bearings in the pallet wheels. On the largest machines a 30-hp. motor is more than sufficient, while a 7½-hp. motor is ample for the smallest ones even though their pallet wheels are provided with plain bearings.

After being laid upon the grates, the charge is fired by means of a specially designed ignition furnace in which gas generally serves as fuel. Under pressure, the gas creates an intense flame which extends the full width of the grates and immediately above the ore mixed with sintering fuel. The latter is ignited by the flame, and thereafter combustion is maintained by the current of air passing through the charge.

Blast-furnace gas, which in most cases is the least expensive ignition fuel, is piped to the inlet of the furnace and is regulated in accordance with the condition of the sintering charge. A great deal of attention is given to the gas supply, as ignition is as important as is the proportioning of the materials that make up the charge. The usual gas-distribution system includes a compressor, a storage tank, automatic control, gauges, and a pipe line that is equipped with the necessary stopcocks and fittings.

In the early days of sintering there was, naturally, a great deal of experimentation with gas burners and compressors, but now, in the large plants at least, it is generally the practice to use Ingersoll-Rand compressors and American Ore Reclamation Company ignition furnaces. The capacity of the compressor varies with the size of the plant, and is based on an average gas consumption of 1,000 cubic feet per ton of sinter with gas of 90 Btu. per cubic foot and at an average pressure of 2 pounds per square inch.

The air-circulating system begins at the wind boxes of the sintering machine and ends at the suction fan. The wind boxes are primarily suction outlets for the combustion gases and serve to retard the passage of heavy particles that drop through the grates. These particles, together with the gases, are directed into a dust-settling chamber connected to the wind-box outlets by a suction pipe. Circulating air and gases, which have been thus cleared,



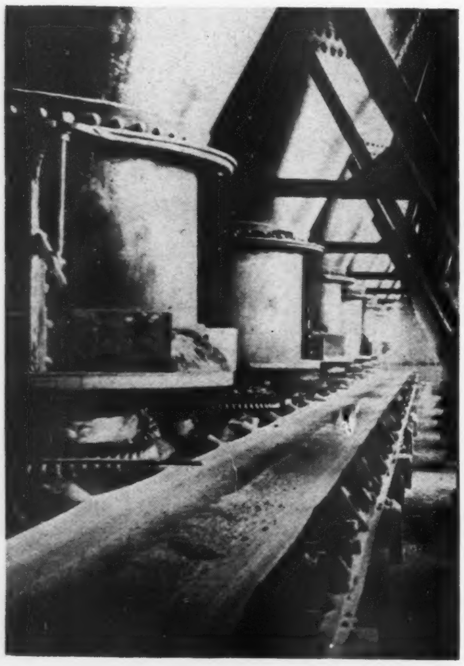
PUG MILL

Within this machine are paddles which mix the flue dust with fuel or diluent. The mixture is moistened before going to the sintering machine on the floor below.

are drawn out of the settling chamber by an impeller-type fan. The latter operates under a pressure of 20 inches of water, and comes in capacities of from 20,000 to 90,000 cfm. and for direct connection to a variable-speed electric motor. Exhaust gases escape into the atmosphere through a brick or steel-plate stack placed near the fan room.

Finished sinter is discharged at the head end of the machine and, after being cooled by water sprays, passes over a screen chute. This allows large pieces to drop into a railroad car, while the smaller particles fall through the screen on to a conveyor which delivers them to the diluent hopper from which they are once more withdrawn to serve as fuel.

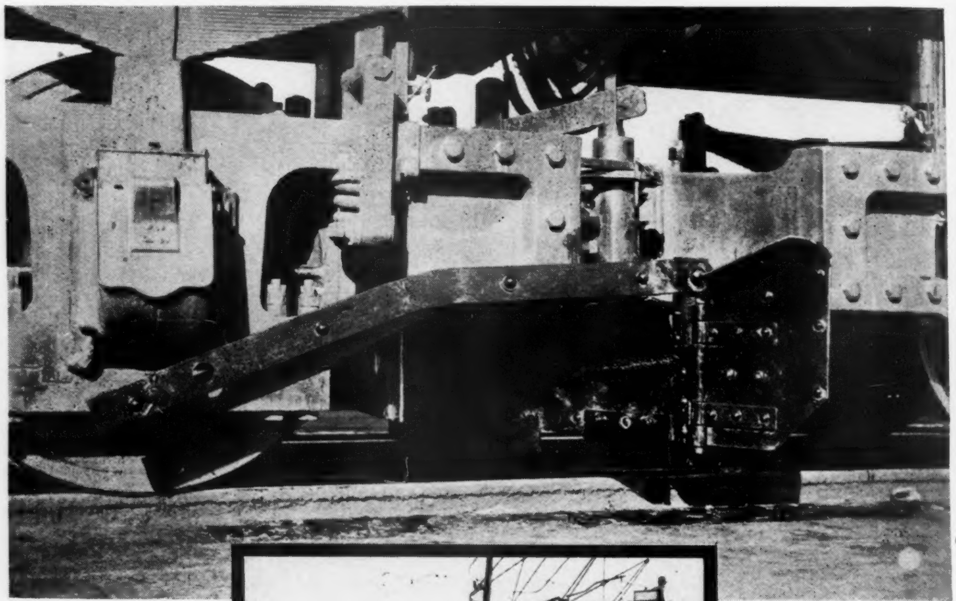
It is safe to say that fears for the future of iron-ore supplies are unfounded, and that existing blast furnaces are inadequate to utilize the material that can be made available by sintering. There are 285 iron blast furnaces in the United States, and of these 50 are equipped with sintering plants. Of the remaining furnaces, 75 are sufficiently large to justify the installation of such machinery. These, with the 50 already built, could work almost indefinitely on the low-grade ores not now merchantable if the blast furnaces used 100 per cent sinter as a charge. No accurate survey of the amount of these ores in the United States has been made, but it is probably a fact that the stores, if used at the 1926 rate, would not be exhausted in less than from three to four centuries.

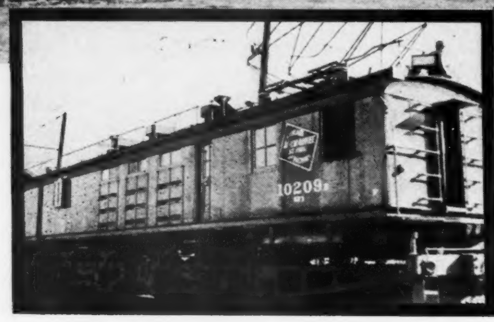


IRON-ORE FEEDER

Regulated amounts of flue dust are automatically fed on to the belt conveyor from the storage hoppers, at the left, which carry a 24 hours' supply. This belt delivers the raw material to the top of the sintering building where fuel and water, properly proportioned, are added to it before the mix is evenly distributed on the slowly moving grates of the sintering machine.

Air-Operated Railroad Snow Plow





THE winter months add to the already many-sided problems of the railroads, especially in mountainous regions where snowfall is apt to be heavy and frequent. Schedules must be maintained, and flanger cars or plows must be run at intervals over the tracks to keep them clear. The electrified section of the Chicago, Milwaukee, St. Paul & Pacific Railroad passes over three such mountain ranges and, until of late, employed a work train and a flanger car for snow removal. This special equipment has been discarded for one of the road's regular electric locomotives which has been outfitted for the purpose and does the work while engaged in its regular service of hauling freight over the line.

The flanger was designed and applied by the road's mechanical department at Deer Lodge, Mont., after the problem of simplifying and lessening the cost of snow removal had been put up to it. It is much like the average snow plow in construction, and is double pointed so as to throw the snow in either direction from the center of the track to the outer edge. This is effected by means of a folding wing which is forced to assume the proper position by the pressure exerted against it by the snow when the train is underway. This flexibility of operation was necessary because there are no means of turning the locomotives at the terminals. By spring-steel strips, at the bottom of the flanger, the snow is cleared out below the rail to a depth of 3 inches.

The flanger is located between the two cabs which constitute the locomotive, and is operated from the foremost cab which has been provided with a special window from which the roadbed can be closely watched. Originally, this was placed at the end of the cab, as shown in the accompanying photograph, but it has since been shifted to a point farther forward where flying snow cannot obstruct the vision of the flange operator who must raise the plow whenever crossings and other obstacles in its path are approached.

To operate the flanger mechanism, air is admitted to a small cylinder of the push-down type by a 3-way valve in the cab. Pressure is thus exerted on wishbone-shaped levers, the ends of which enter slots in pistons to which the plow is fastened. The cylinders actuating these pistons are bolted to the end frame of the locomotive. By admitting air to the latter cylinders the plow is raised, and by exhausting it the plow drops of its own weight to the down and service position in which no pressure is applied to the lower ends of the pistons. Compressed air is required only to raise the plow. When not in use the plow is locked in the "up" position by dogs on either side of the cylinders and held in place by pins. As it is built to standard clearances, no part of the flanger need be dismounted when it is not in service.

For the past two winters the equipment has been in operation on the electrified division of the Chicago, Milwaukee, St. Paul & Pacific Railroad and, according to the division master mechanic, "it works very successfully and does a good job of flanging."

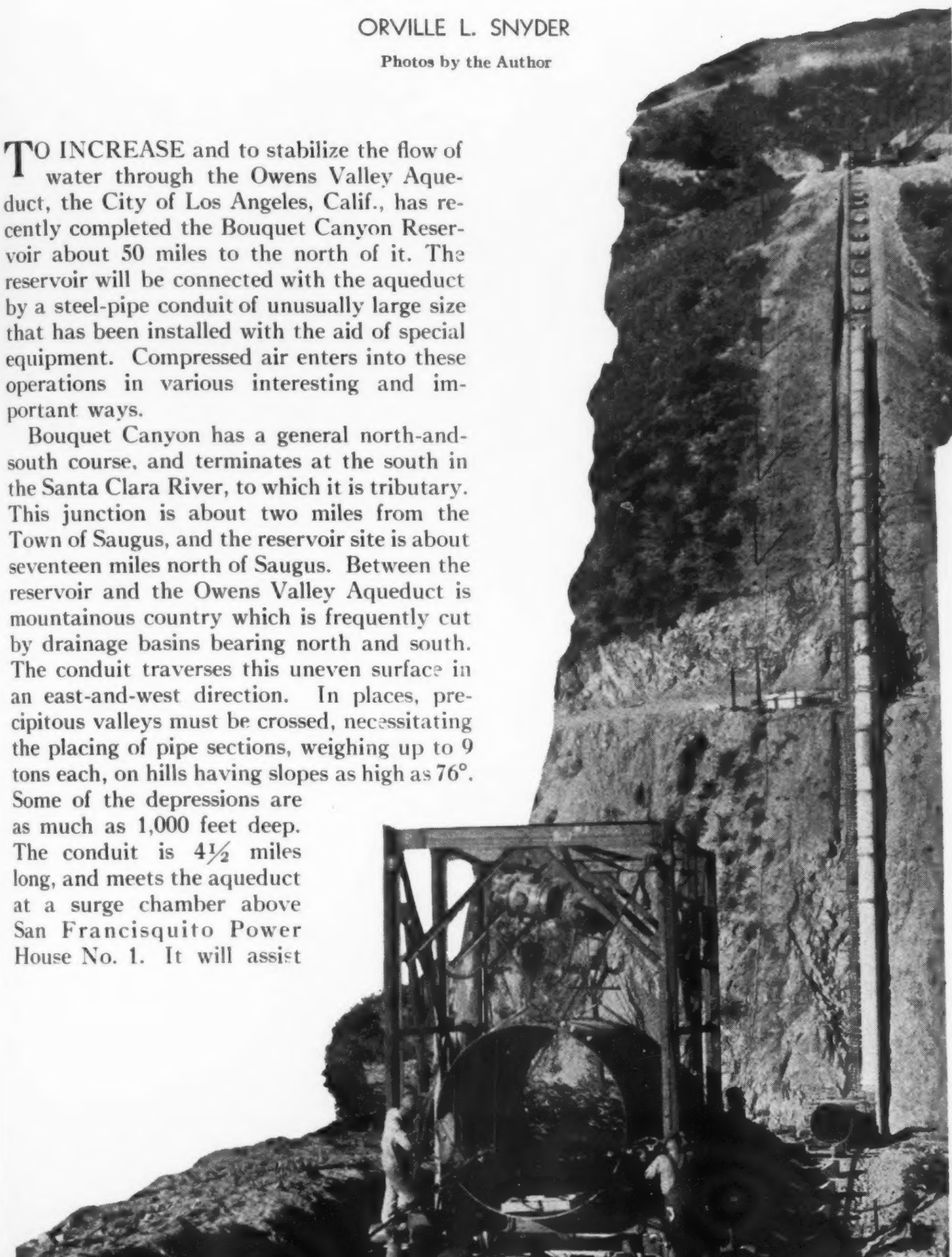
Laying a Huge Pipe Line in Rugged Country

ORVILLE L. SNYDER

Photos by the Author

TO INCREASE and to stabilize the flow of water through the Owens Valley Aqueduct, the City of Los Angeles, Calif., has recently completed the Bouquet Canyon Reservoir about 50 miles to the north of it. The reservoir will be connected with the aqueduct by a steel-pipe conduit of unusually large size that has been installed with the aid of special equipment. Compressed air enters into these operations in various interesting and important ways.

Bouquet Canyon has a general north-and-south course, and terminates at the south in the Santa Clara River, to which it is tributary. This junction is about two miles from the Town of Saugus, and the reservoir site is about seventeen miles north of Saugus. Between the reservoir and the Owens Valley Aqueduct is mountainous country which is frequently cut by drainage basins bearing north and south. The conduit traverses this uneven surface in an east-and-west direction. In places, precipitous valleys must be crossed, necessitating the placing of pipe sections, weighing up to 9 tons each, on hills having slopes as high as 76°. Some of the depressions are as much as 1,000 feet deep. The conduit is 4½ miles long, and meets the aqueduct at a surge chamber above San Francisquito Power House No. 1. It will assist in regulating the aqueduct flow both for power and water-supply purposes.



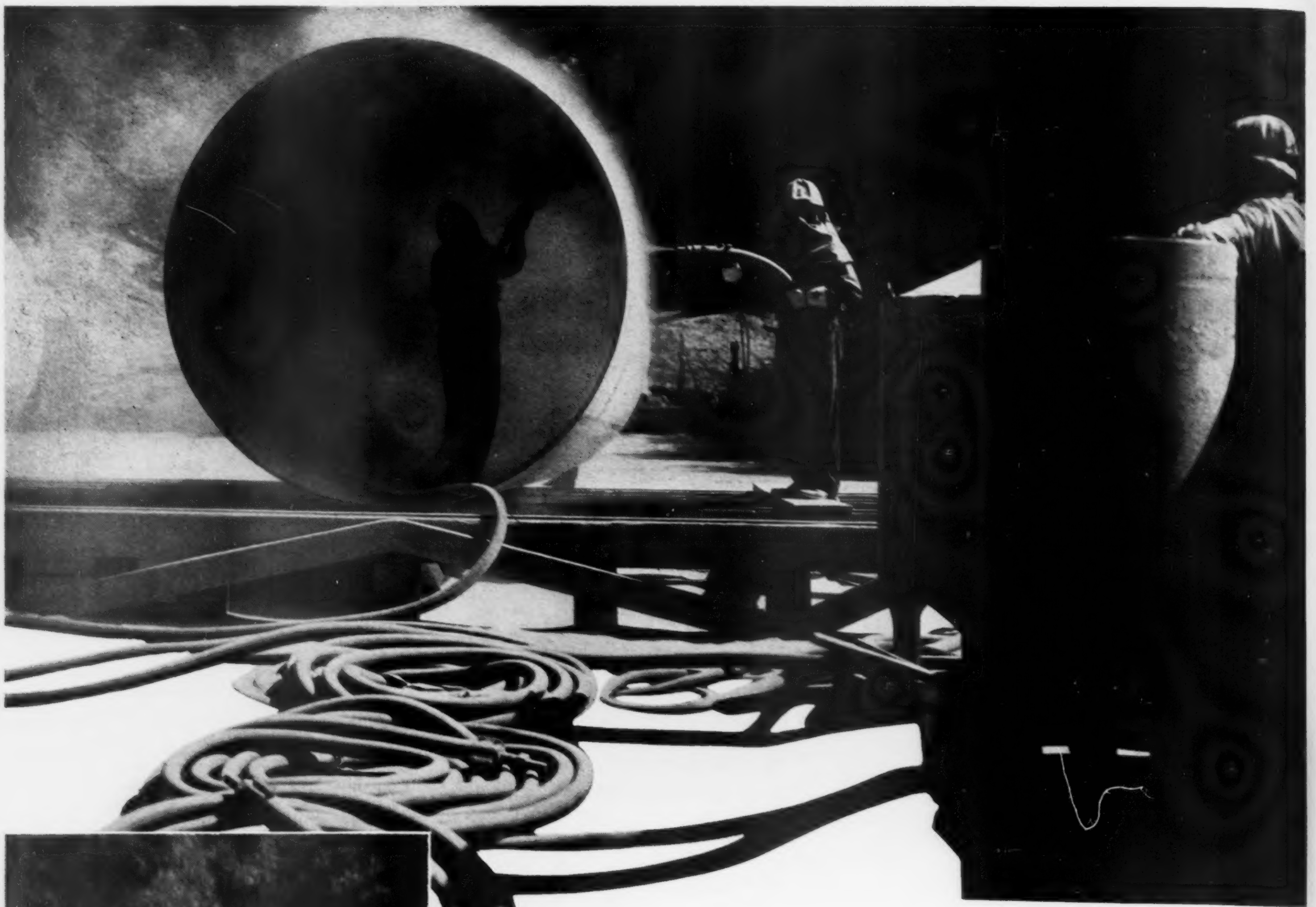
INSTALLING PIPE SECTIONS

A special steel gantry carriage was devised for transporting the heavy pipe sections down the steep slopes and joining them to the segments already in place. This carriage ran on rails laid alongside the concrete foundation piers, and was lowered with a cable operated by a 100-hp. electric hoist stationed at the hilltop. The pipe section was suspended from the carriage by two 5-ton air hoists and, upon reaching its place in the line, was maneuvered by them into the precise position required to connect it with the abutting section.

When the Bouquet Canyon Reservoir is ready for service, it will be floating, as it were, on the main aqueduct. Water will flow either into it or out of it, as conditions determine. When enough water is flowing through the aqueduct from Owens Valley to drive the turbines in San Francisquito power houses Nos. 1 and 2, any surplus water will be directed through the conduit for storage in Bouquet Canyon Reservoir. Conversely, when the Owens Valley supply drops below the prescribed minimum, then water will flow out of the reservoir and into the aqueduct in sufficient volume to permit the generators in the two power houses to turn at the required speed.

Construction of both the Bouquet Canyon Reservoir and the outlet conduit has been in charge of the Los Angeles Bureau of Water and Power. Work was started in January, 1932, and is now so near completion that the storage of water can assuredly start during the coming spring. The undertaking involves expenditures of approximately $4,000,000.

The reservoir will have a capacity of 33,000 acre-feet of water, which is ample to supply Los Angeles for two months. The topographic conditions at the site called for the building of two earth-fill dams and a concrete dike. The larger of the two dams rises 221½ feet above bedrock and 185 feet above the stream bed. It varies in length from 400 feet at the bottom to 1,200 feet at the crest. Approximately 2,800,000 cubic yards of earth went into its



construction. The upstream side of this dam is faced with reinforced concrete varying in thickness from 6 inches at the crest to 9 inches at the toe, and is connected at the toe and the abutments to a reinforced concrete cut-off wall carried down to bedrock. This wall is 10 to 20 feet deep and 4 feet in thickness, and the ground beneath it has been well grouted.

The smaller earth-fill dam was built to close a gap formed by a saddle in the northwestern part of the reservoir site. This dam is 45 feet high and contains about 105,000 cubic yards of material. Another small gap on the west side of the reservoir area was closed by a gravity-section concrete wall 285 feet long and 11 feet high. This dike is designed to serve as a secondary spillway.

Water will flow into or out of the reservoir, as the case may be, through an 8-foot, concrete-lined tunnel which has been driven 1,027 feet through the sandstone and shale ridge which constitutes the western boundary of the basin. This tunnel was advanced from both portals, and was drilled full face by means of two drifter drills mounted on a horizontal bar at each heading. Its 12-inch lining was placed pneumatically. With water at high level in the reservoir, the maximum available head will be 99 feet and the connecting conduit will have a capacity of 700 second-feet. This will range down to a minimum of 450 second-feet as the reservoir water level drops.

At the lowest point between the reservoir and the aqueduct, which is the San Francisquito Canyon crossing, the conduit will be under a maximum static head of 820 feet, and only a small part of the line will be under a head of less than 200 feet. Where the pressure will be greatest, the pipe has a wall thickness of 1.625 inches and its diameter is 80 inches. Where the head will be only 200 feet, the wall thickness is 0.375 inch and the pipe diameter is 94 inches. Throughout the remainder of its length, the diameter and the wall thickness range between the extremes just noted, being made to conform to the pressure load.

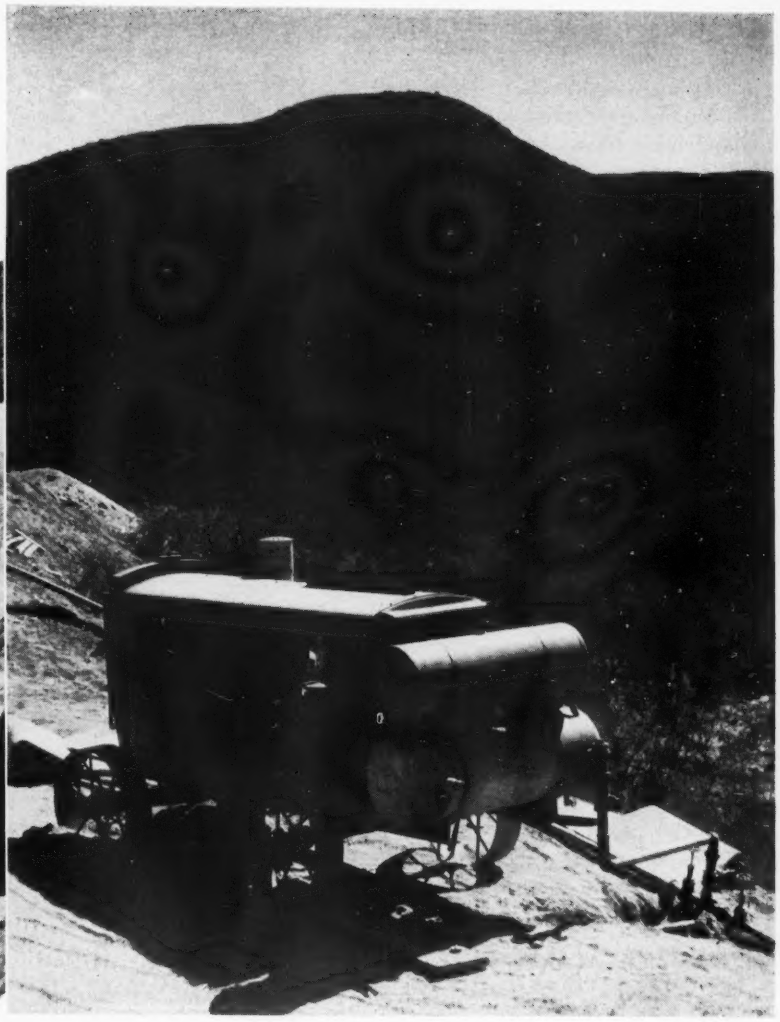
The variation in the size of the conduit called for the construction of both straight and tapered pipe sections. The contract for furnishing, fabricating, and delivering the pipe

A BOMBARDMENT WITH SAND

Before being placed in the line, the pipe sections, ranging from 80 to 94 inches in diameter and from 20 to 30 feet long, were sand blasted inside and out to remove all scale and rust. Two coatings of bitumastic were then applied to the interior, and the outside was sprayed with red-lead paint. After its assembly, the entire line was painted white, and this is being followed with an aluminum finish that is designed to reduce absorption of heat from the sun to a minimum.

CRADLES OF CONCRETE

Concrete foundation piers, the top surfaces of which had curvatures conforming to those of the pipe sections, were prepared in advance of the installation of the latter. Channels were cut with a pneumatic chipping hammer in the outer portions of these pier tops for the purpose of introducing grout after the conduit had been assembled. Compressed air for this chipping, as well as for operating the hoists on the carriages used in placing the pipe sections, was furnished by the 2-stage, air-cooled portable compressor pictured at the right.



was awarded to the Western Pipe & Steel Company of Los Angeles. The steel plate entering into the conduit has a minimum tensile strength of 50,000 pounds per square inch and a yield point of not less than 27,000 pounds per square inch. Variation in the thickness of the plates was limited to 0.01 inch. Pipe was delivered to the job in erection sections 20, 27, and 30 feet long.

A receiving yard was established in San Francisquito Canyon to serve the entire job. There each pipe section was thoroughly treated to protect both its inner and outer surfaces from corrosion. The first operation consisted of sand-blasting it until the steel was etched bright and clean and was free from scale and rust. A thin bitumastic primer coat was then sprayed on the inside and, after a 24-hour drying period, heavy bitumastic enamel heated to 425°F. was applied by brushing. The outside was sprayed with red lead paint. When dry, the pipe sections were trucked to the areas where they were to be installed.

As previously noted, the line cuts across a succession of ridges and canyons, and the rugged nature of the country complicated the problem of emplacement. The method of handling the pipe as finally determined upon was unusual and proved to be effective. Concrete piers for supporting the line had been poured in advance at suitable intervals and, as can be seen in accompanying illustrations, their tops had been given concave surfaces conforming to the curvature of the pipe. Transverse grooves were then cut in these surfaces to create channels which were later grouted, thereby assuring a maximum of contact between the concrete and the steel as well as adequate bearing surfaces.

When ready for installation, the pipe sections that were to be placed on opposing sides of an elevation were transported to the crest of the rise between them. There they were transferred by crane from the trucks to a special carriage, which was called a "straddle-bug" by the men on the job. As shown, this device consisted of a structural-steel framework mounted on flanged wheels, and was designed to travel on rails laid alongside the concrete foundation piers. The carriage was equipped with two Ingersoll-Rand air hoists, each having a capacity of 10,000 pounds. By means of these hoists, each pipe section was held or suspended during its descent down the hillside to the point of installation. The lowering of the carriage was done by a cable operated by a 100-hp. electric hoist at the top of the hill.

After a section of pipe had been thus moved into position, the air hoists were used to lower and to manipulate it until the lips on one end of it were aligned with similar lips on the contiguous end of the section to which it was to be joined. The "straddle-bug" was then drawn up the slope to receive another section of pipe. Two of these carriages were in use, one on each side of the respective elevation. Air for operating their four hoists was supplied by an Ingersoll-Rand Type 40, two-stage, air-cooled portable compressor of 370 cfm. piston displacement. This unit was located at the crest of the rise, and air was piped down the slopes through lines paralleling the work. This air also ran the chipping hammers that made the grooves in the pier tops and served other purposes, such as operating hammers for the making of minor adjustments in the pipe ends when they failed to match perfectly.

The field work was carried on by the Los Angeles Bureau of Water Works and Supply. The first pipe was put in place last September, and the line is scheduled to be completed during the current month. Approximately 100 men have been employed on this phase of the operations, which have been under the direction of H. A. Van Norman, chief engineer and general manager of the bureau, with H. L. Jacques, construction engineer, in charge of the work and John H. Bouney superintending the pipe laying.

After the piping was in position, a coat of white paint was applied to the exterior. The line is being finished with a coat of aluminum, which is designed to reduce absorption of heat from the sun and, correspondingly, to lessen expansion.

AERATION OF ICE-COVERED PONDS SAVES FISHES

WHEN ice forms upon the surface of a shallow pond and remains there for a considerable time, the water becomes deficient in oxygen content and many of the fishes die. The mortality is particularly heavy among the younger fishes. In Iowa, the introduction of air has served to alleviate this condition, and the practice is now being consistently followed.

The first experiments of this sort were conducted several years ago by S. P. Baur, state fish culturist. All ponds less than 7 feet deep were tested twice weekly for their oxygen content, and, when this was low, it was replenished by means of air compressors. Since that time a portable blower has been developed especially for the purpose.

The usual method of aeration is to cut an opening in the ice, through which the end of a 50-foot section of air hose is inserted. The outlet of the hose is kept about 3 feet from the bottom, and is left in that position until the rising air tends to make a hole in the ice above it and to escape. Then the hose is swung about progressively until it has completed a circle, after which the outfit is moved to another location where the operation is repeated. The air which is not immediately taken up by the water rises to the surface, where it is confined by the ice cap and slowly absorbed.

AIR-DRIVEN CALKING HAMMER SEALS JOINT IN UNDERWATER MAIN

BACK in 1914, the City of Richmond, Va., had to augment its water supply for domestic and fire-fighting needs, and for this purpose laid a 20-inch cast-iron pipe line, 3,300 feet long, across the bottom of the James River. Several years later, when leaks developed in the main, it was necessary to surround the damaged sections with cofferdams before repairs could be made. These cofferdams cost from $2,000 to $5,000, and it took from five to six hours to do the repair work after they had been built and pumped out, adding to the outlay to just that extent.

Recently, a leaky joint was detected in the line at a point 7 feet underwater, but this time a far simpler and far less costly method was tried, and with success. An Ingersoll-Rand portable compressor was run on a barge and floated over the spot, and a diver equipped with an air-driven hammer of the same make was sent overboard. With this tool, operating with air at 90 pounds pressure supplied by the portable, the joint was quickly and easily sealed by calking it with lead and at a total cost of only $100!

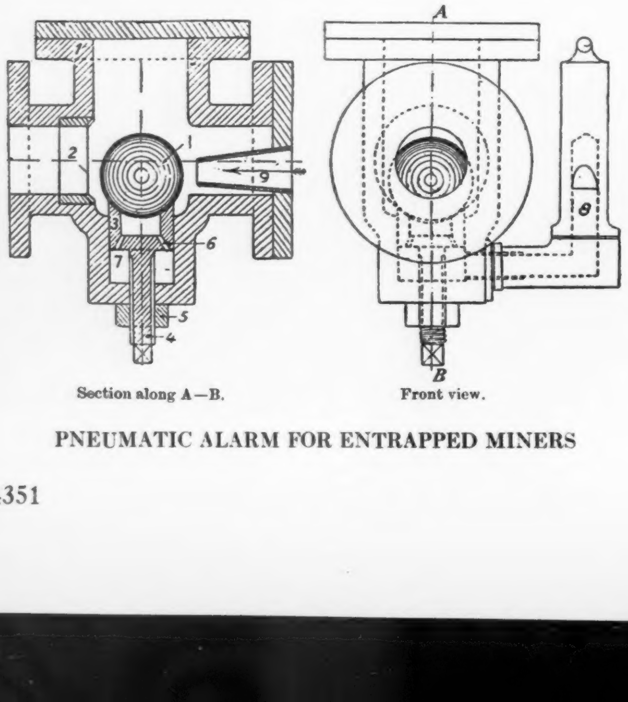
PNEUMATIC ALARM SYSTEM FOR ENTRAPPED MINERS

GASEOUS mines in Belgium have in the past had to be provided with refuge stations equipped with telephones so that men trapped underground as the result of an explosion might seek shelter in them and communicate with rescue squads on the surface. This order of the Belgian Department of Mines has been changed because telephonic communication may be interrupted through failure of the electric system. Managements are now required to take such steps that, "in case of an instantaneous outburst of firedamp or other dangerous gas, any workers who may be shut up in a refuge shall be able to make their plight known in order that assistance may be sent to them as quickly as possible."

Within distances not exceeding 300 yards from the alarm station above ground, men so sheltered can easily make their presence known either by tapping on the compressed-air line or by ringing a bell provided for the purpose. Beyond that point, however, the sounds so produced are not sufficiently penetrating. This difficulty has been overcome by a pneumatic signaling device that has been tested and is said to be highly effective.

The mechanism is simple in construction, and is interposed in the regular main air line at a point above ground constituting the alarm station. It consists essentially of a whistle or siren that can be blown from the several refuge chambers by the turning of an air valve in each. This sudden increase in the air supply causes the whistle to give the warning blasts. The structural features of the device are shown in the accompanying diagrams, for which we are indebted to *Annales des Mines de Belgique.* Under normal conditions, when the air is being used to operate the tools at the various working faces, the ball, 1, of the signaling apparatus, rests on the horizontal seat, 3, which can be adjusted vertically by means of the threaded pin, 4, and the nut, 5. With the ball in this position, the compressed air entering the device by way of the nozzle, 9, flows out again into the main line through the opening opposite. But in case of an emergency, when the valve in the mine shelter is opened wide, the sudden increase in flow unseats the ball and forces it against the vertical seat, 2, sealing that passage and opening up the two channels, 6, in seat 3. This allows the air to flow into chamber 7, and thence on to the siren, 8, causing it to sound its warning blast. This is effected, however, without cutting off the entire mine air supply—grooves in the vertical seat permitting enough air to reach the workings to feed the inhalers in the refuges and to operate fans in the crosscuts.

The equipment had its first try out in the Bois de Cazier colliery; and information has it that the signals were so resonant that they could be heard loud and clear about 185 yards away from the alarm station, the source of the sound.



Section along A—B. Front view.

PNEUMATIC ALARM FOR ENTRAPPED MINERS

FRANK CARROLL

FRANK CARROLL, well known among mining and contracting men, particularly in the western part of the country, died on December 29, at Los Angeles, Calif., following an extended illness. He was 54 years old.

Mr. Carroll had been identified with Ingersoll-Rand Company for more than a quarter of a century. Having had early training as a practical miner, he entered that firm's employ in 1907 as a service man connected with the El Paso, Tex., branch office. Later he became a salesman in western offices of the concern, and then was manager for a short time of the sales office at Juneau, Alaska.

His thorough knowledge of mining and of rock-drilling work in general, combined with an engaging personality, made him a welcome visitor at all the mining properties and other places where his duties took him, and he formed many enduring friendships. His qualifications also brought him recognition from his firm, for he was made general western representative. In that capacity he traveled the section from the Rocky Mountains to the Pacific Coast, and came in contact with virtually every large construction and mining project in that area.

FRANK CARROLL

Because of his familiarity with rock drills, he was called into consultation on many drilling problems, and in 1927 he was transferred to the Ingersoll-Rand general office in New York City as assistant to the executive vice-president, and this position he filled until his death. Mr. Carroll worked closely with the designing engineers at the Phillipsburg, N. J., factory, and played an important part in the production of the more recent types of drills now in use.

Frank Carroll was born July 2, 1879, at Hiawassee, Ga., the son of Samuel S. and Julia Brown Carroll. When he was about three months old, the family moved to Rosita, Colo., a small cattle town near the mining camp of Silver Cliff. The elder Carroll started raising cattle, and the son virtually grew up in the saddle. About 1901 he became interested in mining at Ouray, Colo., where he worked and conducted operations with his brother, Fred, who later became commissioner of mines for Colorado. From Ouray, Frank moved farther west and roamed around in New Mexico, Arizona, and Old Mexico until he began to work for Ingersoll-Rand Company.

His schooling was limited to attendance at grade school and to two years reluctantly spent in high school—his father having practically forced him into the schoolroom when he preferred to be outdoors and astride a horse.

Mr. Carroll was a thirty-second degree Mason and belonged to the Consistory at Juneau, Alaska. He was also a member of the Bohemian Club of San Francisco.

OVERPASS SOLVES AIR-DELIVERY PROBLEM ON BUSY STREET

MARKET STREET, in San Francisco, is known as one of the busiest thoroughfares in the world. It not only carries a large volume of vehicular traffic but also is traversed by four sets of street-car tracks. The two outside tracks are used by the municipal street cars and the two inside tracks by the Market Street Railway cars. Both lines operate with electric power supplied by overhead trolleys. As the average interval between cars is only 30 seconds, it manifestly would be impossible to lay compressed-air lines across the tracks. For this reason it has always been impracticable to use air-driven tools to tear up the pavement in the zone occupied by the car lines whenever improvements or changes required that the street covering be removed. Accordingly, all such work has in the past been done by hand labor.

Recently, however, as a result of the ingenuity of W. Chamberlain, chief engineer of the Market Street Railway, means were provided for conveying compressed air to the area between the two inside tracks without interfering with the car service. Mr. Chamberlain's method was the simple one of carrying the air hose over the trolley wires and down again to the street level. The accompanying illustration shows how this was done.

At intervals along the curb line are steel electric-light standards which also serve as supports for wires which span the street and which, in turn, carry the four trolley wires that supply the street cars. Air hose leading from a portable compressor stationed at the curb line was run up one of these standards, and thence above the two trolley wires on that side of the street to the top of a temporary pole erected between the two inside tracks. The hose was carried down this upright to the street, from which point air could be supplied to tools through suitable pipe and hose connections. The portion of the hose which crossed the trolley wires was left in place overnight, while the connecting lines at street level were uncoupled and removed so as not to interfere with vehicular traffic during the non-working hours.

This method was successfully used during an extensive track-repair job which involved removing the strip of pavement between the two inside car tracks, and it served to speed up the operations considerably as compared with the rate at which it can be done by conventional hand methods.

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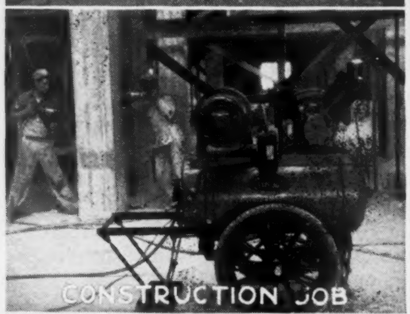

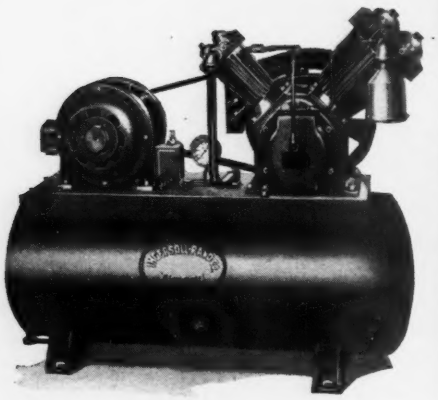

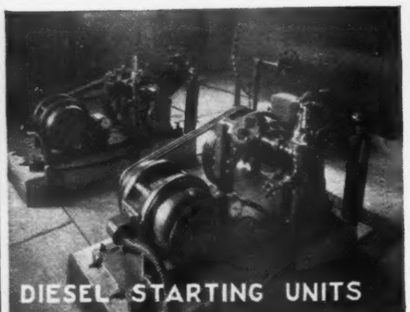

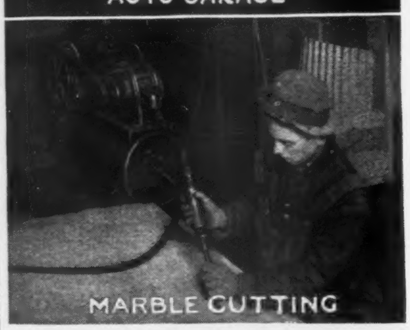

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